

UNCLASSIFIED

AD NUMBER

**AD842931**

NEW LIMITATION CHANGE

TO

**Approved for public release, distribution  
unlimited**

FROM

**Distribution authorized to U.S. Gov't.  
agencies and their contractors; Critical  
Technology; AUG 1968. Other requests shall  
be referred to Commanding Officer,  
Edgewood Arsenal, Attn: SMUEA-TSTI-T,  
Edgewood Arsenal, MD 21010.**

AUTHORITY

**USAEA ltr, 22 Dec 1971**

THIS PAGE IS UNCLASSIFIED

1  
2  
3  
4  
5  
6  
7  
8  
9  
A

AD

EDGEWOOD ARSENAL  
SPECIAL PUBLICATION

EASP 100-33

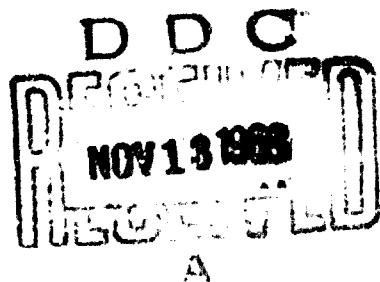
FREE RADICALS: A BIBLIOGRAPHY  
VOLUME I, 1963-1964

by

Edward J. Poziomek  
Research Laboratories

William A. Mosher  
University of Delaware

August 1968



DEPARTMENT OF THE ARMY  
EDGEWOOD ARSENAL  
Research Laboratories  
Physical Research Laboratory  
Edgewood Arsenal, Maryland 21010

Distribution Statement

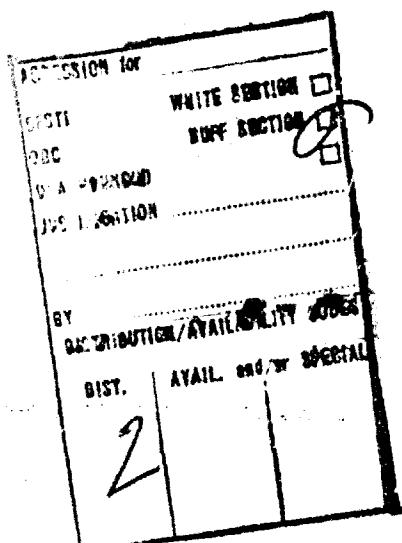
This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-TSTI-T, Edgewood Arsenal, Maryland 21010.

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Disposition

Destroy this report when no longer needed. Do not return it to the originator.



EDGEWOOD ARSENAL SPECIAL PUBLICATION

EASP 100-33

FREE RADICALS: A BIBLIOGRAPHY  
VOLUME I, 1963-1964

by

Edward J. Poziomek

Defensive Research Department

and

William A. Mosher

University of Delaware

August 1968

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-TSTI-T, Edgewood Arsenal, Maryland 21010.

Project 1C622401A102  
Task 1C622401A10204

DEPARTMENT OF THE ARMY  
EDGEWOOD ARSENAL  
Research Laboratories  
Physical Research Laboratory  
Edgewood Arsenal, Maryland 21010

## FOREWORD

This work was authorized under Project 1C622401A102, Chemical Agent Warning and Detection Techniques (U), Task 1C622401A10204, Detection and Warning Investigations (U). The work was started in January 1963 and Completed in June 1967.

Reproduction of this document in whole or in part is prohibited except with permission of the Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-TSTI-T, Edgewood Arsenal, Maryland 21010; however, DDC is authorized to reproduce the document for United States Government purposes.

The information in this document has not been cleared for release to the general public.

## Acknowledgment

The authors wish to acknowledge Mrs. Florence C. Burnett, Technical Information Division, Technical Support Directorate, for her capable assistance in preparing the bibliography for publication.

## DIGEST

This special publication lists 1672 references on free radicals found by the author as a result of a page to page scan of the 1963 to 1964 issues of the Physical and Analytical Chemistry Sections, and the Organic Chemistry Sections of Chemical Abstracts. This publication is divided into 10 sections: Synthesis, Reactions of Free Radicals, Reactions Through Free-Radical Mechanisms, Metal Ions and Free Radicals, Electron Spin Resonance, Spectroscopy, Photolysis, Radiolysis, Electric and Magnetic Phenomena, and General Considerations. The references are arranged alphabetically in each section according to first author. Each reference contains the author, title, and journal citation.

## CONTENTS

	<u>Page</u>
INTRODUCTION.....	7
SYNTHESIS (Item Numbers 1 to 152).....	7
REACTIONS OF FREE RADICALS (Item Numbers 153 to 354) ...	21
REACTIONS THROUGH FREE RADICAL MECHANISMS (Item Numbers 355 to 530).....	40
METAL IONS AND FREE RADICALS (Item Numbers 531 to 606).	56
ELECTRON SPIN RESONANCE (Item Numbers 607 to 1000) ....	63
SPECTROSCOPY (Item Numbers 1001 to 1058).....	100
PHOTOLYSIS (Item Numbers 1059 to 1233).....	105
RADIOLYSIS (Item Numbers 1234 to 1413).....	121
ELECTRIC AND MAGNETIC PHENOMENA (Item Numbers 1414 to 1510) .....	139
GENERAL CONSIDERATIONS (Item Numbers 1511 to 1672) ....	148
DISTRIBUTION LIST.....	163
DD FORM 1473 (DOCUMENT CONTROL DATA - R&D) .....	177

FREE RADICALS: A BIBLIOGRAPHY  
VOLUME I, 1963-1964

INTRODUCTION.

In 1961, a report\* was published that surveyed the free-radical literature up to and including the year 1959. Approximately 2,200 references were presented in the form of the title of the paper, the author, and a brief description of the work when the title was not self-explanatory.

Since 1963, there has been continuing interest by the US Army to use free-radical chemistry for sustaining chain reactions in chemical detection and warning applications. The current bibliography was compiled to aid these free-radical investigations and covers the years 1963 to 1964. Another report encompassing the years 1965 to 1966 is in preparation. Future plans also call for filling the gap between 1959 and 1963.

These publications will be of interest to any Army scientist conducting free-radical research.

SYNTHESIS.

1. Acker, Donald S., and Hertler, Walter R. Substituted Quinodimethans. I. Preparation and Chemistry in 7,7,8,8-Tetracyano-quinodimethan. *J. Am. Chem. Soc.* 84, 3370 (1962).

2. Arbuzov, A. E., Valitova, F. G., Il'yasov, A. V., Kozyrev, B. M., and Yablokov, Yu. V. Electron Paramagnetic Resonance (E.P.R.) in Solutions of Some Free Radicals of the Phosphohydrazyl Series. *Dokl. Akad. Nauk SSSR* 147, 839 (1962).

3. Barachevskii, V. A., Kholmogorov, V. E., Kotov, E. I., and Terehin, A. N. Absorption and Electron Paramagnetic Resonance Spectra of Positive Acene Ions Formed on Vacuum Adsorption. *Ibid.*, 1108 (1962).

\* Lavin, G. I., Coates, A. D., and Rakaczky, J. A. BRL Report 1142, AD 266806. Free Radicals, Bibliography and Survey of Publications (up to 1959). August 1961. UNCLASSIFIED Report.

4. Battiste, Merle A. The Heptaphenyltropylium (Hepta-phenylcycloheptatrienyl) Radical in Solution. *J. Am Chem. Soc.*, 84, 3780 (1962).

5. Bauld, Nathan L. Stable Dianion Radicals and Trianions in Substituted Pentadionyl Systems. *Ibid.* 86, 2305 (1964).

6. Bauld, Nathan L. Stable Trianion Radicals. *Ibid.* 3894 (1964).

7. Bennett, J. E., and Thomas, A. The Chemical Preparation and Electron-Spin Resonance (E.S.R.) Spectra of Specific Trapped Hydrocarbon Radicals. *Proc. Roy. Soc. (London) Ser. A* 280, 123 (1964).

8. Berger, H. Decomposition of Organic Hydroperoxides. V. Decomposition of tert-Butyl Hydroperoxide Catalyzed by Nitriles and Base. *Trans. Faraday Soc.* 58, 1137 (1962).

9. Berlin, A. A., Liogon'kii, B. I., Ragimov, A. V., and Vonsyatskii, V. A. Polymeric Semiquinone Polyradicals With High Stability. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1351 (1963).

10. Bogdanov, G. N., and Ershov, V. V. New Stable Phenoxy Radicals. *Ibid.*, 1516 (1963).

11. Bogdanov, G. N., Postnikova, M. S., and Emanuel, N. M. Formation of Phenoxyl Radicals in Oxidation of Phenols With Lead Tetraacetate. *Izv. Akad. SSSR, Otd. Khim. Nauk.*, 173 (1963).

12. Bond, A., and Mason, H. S. Semiquinone Phosphate: An Oxidation Intermediate of Haphthoquinol Phosphates. *Biochem. Biophys. Res. Commun.*, 9, 574 (1962).

13. Briere, R., Lemaire, H., and Rassat, A. Nitroxides. VI. Stable Piperidine and Pyrrolidine Free Radicals. Effects of Solvents on the Ultraviolet and Electron Paramagnetic Resonance Spectra. Conformational Mobility of Radicals. *Tetrahedron Letters*, 1775 (1964).

14. Brodskii, A. I., Pokhodenko, V. D., and Ganyuk, L. N. Transformation of Free Radicals Formed by Oxidation of Sterically Hindered Phenols. *Roczniki Chem.* 38, 105 (1964).

15. Cerny, O., and Hajek, J. Radical Formation in Catalyzed Oxidation of Tetralin in the Liquid Phase. Collection Czech. Chem. Commun. 29, 1643 (1964).
16. Chandross, Edwin A. Bisgalvinoxyl, A Stable Triplet. J. Am. Chem. Soc. 86, 1263 (1964).
17. Chandross, Edwin A., and Kreilick, Robert. Electronic Interactions in Biradicals. II. A Singlet-Triplet Equilibrium. Ibid., 117 (1964).
18. Childs, A. F., Gibbs, E. M., and Johnson, J. D. A. p-Phenylbenzophenone. Chem. Ind. (London), 122 (1963).
19. Cohen, Saul G., and Nicholson, Jesse. Formation of Phenyl Radical by Heterolysis of N-phenyl-N'-benzoyldiimide. J. Am. Chem. Soc. 86, 3892 (1964).
20. Colburn, Charles B., Ettinger, Raymond, and Johnson, Frederick A. Isolation and Storage of Free Radicals on Molecular Sieves. II. The Electron Paramagnetic Resonance Spectrum of Nitrogen Difluoride ( $NF_2$ ). Inorg. Chem. 3, 455 (1964).
21. Coppens, P., and Tench, A. J. Free Radicals Formed on Ultraviolet Irradiation of o-Nitrobenzaldehyde. US Atomic Energy Commission. BNL-6161. 8 pp. 1961.
22. Corbett, P., and Whittle, E. The Thermal Decomposition of Perfluoroacetic Anhydride. J. Chem. Soc., 3247 (1963).
23. DeJongh, Don C. 2-Norbornyl and 5-Norbornen-2-yl Free Radicals. Dissertation Abstr. 24, 968 (1963).
24. Denes, Vicrica I., Farasan, Marcela, and Ciurdaru, Gheorghe. Methylene Bases of Heterocycles. IV. Addition of Acid Chlorides to N-methyl-2-methylenebenzothiazoline Dimer. Ber. 97, 1246 (1964).
25. Denisov, E. T. Formation of Free Radicals During the Reaction of Hydroperoxides With Ketones. Zh. Fiz. Khim. 37, 1896 (1963).
26. Denisov, E. T. Formation of Free Radicals in the Reaction of Hydroperoxide With Cyclohexanone. Dokl. Akad. Nauk SSSR 146, 394 (1962).

27. Denisov, E. T. Role of Hydrogen Bonds in the Formation of Radicals From Hydroperoxides. *Zh. Fiz. Khim.* 38, 2085 (1964).
28. Denisov, E. T. Simple Reactions of Formation of Free Radicals in Liquid Phase Oxidation. *Ibid.*, 3 (1964).
29. Denisov, E. T., and Denisova, L. N. Formation of Radicals in the Reaction of Hydroperoxide With the Double Bond of Styrene. *Dokl. Akad. Nauk SSSR* 157, 907 (1964).
30. Derbyshire, H., and Patrick, C. R. Isomerization of 1,2-Dichloroethylene Induced by Chlorodifluoromethyl Radicals - Formation of Metastable Radicals. *Nature* 199, 68 (1963).
31. Dimroth, K., Umbach, W., and Bloecher, K. H. Bis-phenoxy Radicals of the Polypheyl Series. *Angew. Chem.* 75, 860 (1963).
32. Dixon, W. T., and Norman, R. O. C. Electron Spin Resonance (E.S.R.) Studies of Oxidation. I. Alcohols. *J. Chem. Soc.*, 3119 (1963).
33. Dupeyre, R. M., Lemaire, H., and Rassat, A. Electron Spin Resonance (E.S.R.) Studies of Oxidation. VII. Stable Pyrrolidine Free Radicals. *Ibid.*, 1781 (1963).
34. Eargle, D. H., Jr., and Kaiser, E. T. Effect of Changes in the Oxidation State on the Electron Paramagnetic Resonance (E.P.R.) Spectra of Dibenzothiophene Anion Radicals. *Proc. Chem. Soc.*, 22 (1964).
35. Eisch, John J. Alkali Metal-Unsaturated Hydrocarbon Adducts. III. Cleavage Reactions by Lithium-Biphenyl Solutions in Tetrahydrofuran. *J. Org. Chem.* 28, 707 (1963).
36. Eloranta, Jorma. Substituent Effects in the Formation of Free Radical Ions. I. The Absorption Spectra of Free Radical Ions Produced From  $\alpha$ -Chloronaphthalene in Tetrahydrofuran. *Suomen Kemistilchi* 36B, 151 (1963).
37. Eloranta, Jorma. The Free Radical Ions Derived From  $\alpha$ - and  $\beta$ -Naphthols. *Ibid.*, 33 (1963).

38. Ermolaeva, V. G., and Shchukina, M. N. Pyridylthiazolyl-methane Series. I. Synthesis and Properties of 4-Pyridyl-2-thiazolylcarbinol. Formation of Free Radicals. *Zh. Obshch. Khim.* 32, 2664 (1962).
39. Fairbairn, A. R. Temperature Measurements of C<sub>2</sub> and CN Radicals Generated in a Shock Tube. II. Detonation. *Proc. Roy. Soc. (London) Ser. A* 276, 513 (1963).
40. Fischer, H. Formation of Cyclohexadienyl Radicals From the Reaction of Hydrogen Atoms With Solid Benzene. *Z. Naturforsch.* 17a, 693 (1962).
41. Flournoy, John M., Siegel, Seymour, and Judeikis, Henry S. Radical Formation and Trapping in Tritium-Enriched Ice. US Dept. Com., Office Tech. Serv., AD 265, 956, 11 pp. 1961.
42. Fogo, James K. Electron Spin Resonance of Aromatic Hydrocarbons on Silica-Alumina Catalysts. *J. Phys. Chem.* 65, 1919 (1961).
43. Forrester, A. R., and Thomson, R. H. Stable Nitroxide Radicals. *Nature* 203, 74 (1964).
44. Fukui, K., Kawamura, T., Masuda, T., and Morokuma, K. Electron Spin Resonance Study of Free Radicals From Saturated Hydrocarbons and Antimony Pentachloride. *Tetrahedron Letters*, 433 (1964).
45. Gerdil, R., and Lucken, E. A. C. Action of Alkali Metals on Organic Sulfur Compounds. II. The Cleavage of Diphenyl Sulfide by Potassium in Ethereal and Hydrocarbon Solvents. *J. Chem. Soc.*, 5444 (1963).
46. Gerdil, R., and Lucken, E. A. C. Radical Anions Containing Sulfur Atoms in a Conjugated System. *Proc. Chem. Soc.*, 144 (1963).
47. Ghormley, J. A. The Formation of Hydrogen Sesquioxide, H<sub>2</sub>O<sub>3</sub>, in Free-Radical Reactions on Cold Surfaces. *J. Chem. Phys.* 39, 3539 (1963).
48. Gilbert, B. C., Norman, R. O. C., and Price, D. C. Iminoxy Radicals. Hyperfine Splitting in Electron Spin Resonance Spectra Due to 1,6-Interactions. *Proc. Chem. Soc.*, 234 (1964).

49. Gorbunova, L. V., Khidekel, M. L., and Razuvayev, G. A. Free Radicals in Oxidation of Phenols in the Presence of Complex Catalysts. *Dokl. Akad. Nauk SSSR* 147, 368 (1962).
50. Gragerov, I. P., and Turkima, M. Ya. Isotopic and Mass-Spectroscopic Investigation of Mechanism of Homolytic Reactions in Solution. III. Thermal Decomposition of Benzoyl Peroxide and Photolysis of Iodobenzene. *Zh. Obshch. Khim.* 33, 1894 (1963).
51. Gragerov, I. P., and Turkima, M. Ya. Isotopic and Mass-Spectroscopic Investigation of Mechanism of Homolytic Reactions in Solution. IV. Reaction of Iodobenzene With Magnesium and Sodium. *Ibid.*, 1901 (1963).
52. Gragerov, I. P., and Turkima, M. Ya. Isotopic and Mass-Spectroscopic Investigation of Mechanism of Homolytic Reactions in Solution. V. Thermal Decomposition of Diazonium Salts and the Gomberg-Bachmann Reaction. *Ibid.*, 1907 (1963).
53. Gragerov, I. P., and Turkima, M. Ya. Isotopic and Mass-Spectroscopic Investigation of Mechanism of Homolytic Reactions in Solution. VI. Photolysis of Diphenylmercury, Methyl Iodide, and Ethyl Iodide. *Ibid.*, 1910 (1963).
54. Greene, Frederick D., Chu, Chin-Chiun, and Walia, Jasjit. Decomposition of Alkyl Hypochlorites. The 4-tert-Butylcyclohexyl Radical. *J. Org. Chem.* 29, 1285 (1964).
55. Hedaya, E., Hinman, R. L., Kibler, L. M., and Theodoropoulos, S. Stability of Succinimidyl Radical. Decomposition of tert-Butyl N-succinimidepercarboxylate. *J. Am. Chem. Soc.* 86, 2727 (1964).
56. Hertler, W. R., Hartzler, H. D., Acker, D. S., and Benson, R. E. Substituted Quinodimethans. III. Displacement Reactions of 7,7,8,8-Tetracyanoquinodimethan. *Ibid.* 84, 3387 (1962).
57. Hewgill, F. R., Stone, T. J., and Waters, William A. Aryloxy Radicals. II. Application of Electron Spin Resonance to the Elucidation of Reaction Mechanisms. *J. Chem. Soc.*, 408 (1964).
58. Hirota, Kozo, and Kageyama, Yoichi. Stable Radicals of a High Molecular Weight Produced by Oxidizing Diphenylamine With Vanadium Pentoxide. *Bull. Chem. Soc. Japan* 37, 593 (1964).

59. Hozlov, Yu. I., and Shigorin, D. N. Production of Free Radicals of the Triphenylmethyl Series. Izv. Akad. Nauk SSSR, Ser. Fiz. 27, No. 1, 14 (1963).
60. Hsu, Kuang-Chih, Ch'en, Su-Min, Chen, Tzu-Ping, and T'ang, Yu-Ch'i. Electron Spin Resonance (E.S.R.) Spectroscopy of Free Radicals Formed From the Reaction of Aromatic Hydrocarbons and Aromatic Amines With Lewis Acid. K'o Hsueh T'ung Pao, 47 (1964).
61. Huang, R. L., and Lee, H. H. Steric Influences in Radical Reactions. I. Benzyl Radicals Derived From Cyclic Homologs of Dibenzyl Ether. J. Chem. Soc., 2500 (1964).
62. Huenig, S., Friedrich, H. J., Scheutzow, D., and Brenninger, W. New Type Radical Ions - Compounds of the Indolizine Series. Tetrahedron Letters, 181 (1964).
63. Huenig, S., Scheutzow, D., and Friedrich, H. J. Stable Radical Cation of a Hydrocarbon. Angew. Chem. 76, 818 (1964).
64. Ikrina, M. A., and Matevosyan, R. O. Chemistry of Free Radicals of Hydrazine Series. XV. Synthesis of  $\alpha, \alpha$ -Diphenyl- $\beta$ -triphenylmethylhydrazyl and  $\alpha, \alpha$ -Diphenyl- $\beta$ -tris(p-nitrophenyl)methylhydrozyl and a study of Their Properties. Zh. Obshch. Khim. 34, 142 (1964).
65. Ikrina, M. A., and Matevosyan, R. O. The Chemistry of Free Radicals of the Hydrazine Series. VIII. Synthesis of  $\alpha, \alpha$ -Diphenyl- $\beta$ -(2, 6-dinitro-4-sulfophenyl)hydrazyl and  $\alpha, \alpha$ -Diphenyl- $\beta$ -(2, 4-dinitro-6-sulfophenyl)hydrazyl. Ibid. 32, 3952 (1962).
66. Kaiser, E. T., and Eargle, D. H., Jr. Electron Spin Resonance Study of the Anion Radicals of cis- and trans-Thianthrene 5,10-Dioxide. J. Chem. Phys. 39, 1353 (1963).
67. Karpitskaya, V. E., Dolidze, I. A., and Ashkinazi, M. S. Formation of Free Radicals in Autoxidation Reactions Which are Photo-sensitized by Chlorophyll and Pheophytin. Dokl. Akad. Nauk SSSR 146, 844 (1962).
68. Kataoka, Hirohisa, and Nakagawa, Masazumi. Acetylenic Analogs of the Chichibabin Hydrocarbon. Bull. Chem. Soc. Japan 36, 799 (1963).

69. Kauffmann, Th., and Hage, S. M. Stable Radicals by Addition of Sodium to Aromatic Nitroso Compounds. *Angew. Chem.* 75, 295 (1963).
70. Kauffmann, Th., and Hage, S. M. Stable Radicals by the Reaction of Sodium on Diazomethane Derivatives and on Phenyl Azide. *Ibid.*, 248 (1963).
71. Keiler, J. A. Oxidation Products of Phenidone. II. The Free Radical of 1-Phenyl-3-pyrazolidone. *Z. Chem.* 4, 231 (1964).
72. Keiler, J. A. Phenidone Oxidation Products. I. Demonstration and Stabilization of a Radical From the Oxidation Products of 1-Phenyl-3-pyrazolidinone. *Z. Wiss. Photo., Photophysik. Photochem.* 57, 195 (1963).
73. Koester, R., Benedikt, G., and Schroetter, H. W. Stable Free Radicals With B-N and Al-N Linkages. *Angew. Chem.* 76, 649 (1964).
74. Kolker, P. L., and Waters, William A. Electron Spin Resonance (E.S.R.) of Some Nitrobenzene Radical Anions. *Proc. Chem. Soc.*, 55 (1963).
75. Koritskii, A. T., and Lukovnikov, A. F. Formation of Diarylamine Oxide Radicals in Reactions Between Amines and Peroxide Radicals. *Dokl. Akad. Nauk SSSR* 147, 1126 (1962).
76. Kosower, E. M., and Poziomek, E. J. Isolation and Distillation of the Stable Free Radical, 1-Ethyl-4-carbomethoxypyridinyl. *J. Am. Chem. Soc.* 85, 2035 (1963).
77. Kuhn, R., and Neugebauer, F. A. Aza-Isologs of Highly Acidic Hydrocarbons. *Monatsh.* 94, 1 (1963).
78. Kuhn, R., and Neugebauer, F. A. Bis(biphenylene)-2-azaallyl. *Ibid.*, 16 (1963).
79. Kuhn, Richard, and Trischmann, H. Conspicuously Stable N-Containing Radicals. *Angew. Chem.* 75, 294 (1963).
80. Kuhn, Richard, and Trischmann, Heinrich. Verdazyls, A New Class of Cyclic N-Containing Radicals. II. *Monatsh.* 95, 457 (1964).

81. Kuhn, Richard, Neugebauer, F. A., and Trischmann, H. Tetraazapentenyl Radicals. *Angew. Chem.* 76, 230 (1964).
82. Kuo, Te-Liang. Electron Spin Resonance (E.S.R.) of Stabilized Free 1,3,5-Triphenylformazan Radicals. *K'o Hsueh T'ung Pao*, 55 (1963).
83. Lagercrantz, Carl. Free Radicals in Reactions of Tetr-nitromethane as Studied by Electron Spin Resonance. II. Reactions With Unsaturated Compounds and With Dithionite in Alkaline Media and in Pyridine. *Ibid.* 18, 382 (1964).
84. Lagercrantz, Carl. Free Radicals in the Autoxidation of Ascorbic Acid. *Ibid.*, 562 (1964).
85. Lagercrantz, Carl, and Yhland, Margareta. Free Radicals in Aqueous Alkaline Solutions of Tetracycline Derivatives. *Acta Chem. Scand.* 17, 2568 (1963).
86. Leftin, H. P., Hobson, M. C., and Leigh, J. S. The Effect of Gases on the Electron Spin Resonance (E.S.R.) Spectrum of Chemisorbed Diphenylethylene. *J. Phys. Chem.* 66, 1214 (1962).
87. Lemaire, Henri, Rassat, Andre, and Ravet, Anne Maria. A New Free Radical: Phenyl tert-Butyl Nitroxide. *Bull. Soc. Chim. France*, 1980 (1963).
88. Ley, K. A New o-Aminophenol Synthesis. *Angew. Chem.* 74, 871 (1962).
89. Ley, Kurt. Radical Salts. *Farbenfabriken Bayer A.-G. German Patent* 1,147,238. April 18, 1963.
90. Lucken, E. A. C. 1,4-Dithiinium Radical Cations. *J. Chem. Soc.*, 4963 (1962).
91. Lucken, E. A. C. Free Radical Phosphobetaines. *Z. Naturforsch.* 18b, 166 (1963).
92. Lucken, E. A. C. The Electron-Spin Resonance (E.S.R.) Spectra of 1,4-Dithiin Radical-Cations and the Nature of the Carbon-Sulfur π Bond. *Theoret. Chim. Acta* 1, 397 (1963).

93. Matevosyan, R. O. Chemistry of Free Radicals of Hydrazine Series. XIII. Synthesis of Phenylbenzyl-, Phenylbenzoyl- and Phenylcyclohexylpicrylhydrazines and a Study of Their Properties. *Zh. Obshch. Khim.* 34, 133 (1964).
94. Mazitova, F. N., Ryzhmanov, Yu. M., Yablokov, Yu. V., and Durova, O. S. Application of Electron Paramagnetic Resonance to the Study of Oxidation of Aminoalkylphenols by Benzoyl Peroxide. *Dokl. Akad. Nauk SSSR* 153, 354 (1963).
95. Medzhidov, A. A., Buchachenko, A. L., Rozantsev, E. G., and Neiman, M. B. Chromatographic Separation of Radicals Formed in the Oxidation of Hydrogenated 2, 2, 4-Trimethylquinolines. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1713 (1963).
96. Melby, L. R., Harder, R. J., Hartler, W. R., Mahler, W., Benson, R. E., and Mochel, W. E. Substituted Quinodimethans. II. Anion-Radical Derivatives and Complexes of 7, 7, 8, 8-Tetracyanoquinodimethan. *J. Am. Chem. Soc.* 84, 3374 (1962).
97. Merkle, F. H., Discher, C. A., and Felmeister, A. Separation and Investigation of a Stable Solid Free Radical of Chlorpromazine. *J. Pharm. Sci.* 53, 965 (1964).
98. Neiman, M. B., and Buchachenko, A. A. L. Structure and Reaction Capacity of Some Stable Radicals. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 1742 (1961).
99. Neiman, M. B., Medzhidov, A. A., Rozantsev, E. G., and Skripko, L. A. New Reaction to Form Stable Wurster's Salts. *Dokl. Akad. Nauk SSSR* 154, 387 (1964).
100. Neunhoeffer, O., and Tomaschewski, G. Ion Radicals in the Oxidation of Aromatic Phosphorus Compounds. *Z. Chem.* 2, 151 (1962).
101. Neunhoeffer, Otto, and Heitmann, Peter. Free Radicals With Betaine-Limiting Structure. *Ber.* 96, 1027 (1963).
102. Orr, J. D. Electron Spin Resonance (E.S.R.) Examination of Molecules Related to the Isoalloxazine Ring System. *Nature* 201, 816 (1964).
103. Patmore, Edwin L., and Gritter, Roy J. Substituent Effects on Free Radical Formation. *J. Org. Chem.* 27, 4196 (1962).

104. Peterson, Donald John. Trapping of Organometallic and Organometalloidal Radicals. *Dissertation Abstr.* 23, 444 (1962).
105. Petrov, E. S., Yakovleva, E. A., and Shatenshtein, A. I. A Comparison of the Effect of Solvents on Formation of Anion-Radicals and Carbanions. *Zh. Obshch. Khim.* 33, 107 (1963).
106. Piskunov, A. K., Kholmogorov, V. E., Shigerin, D. N., Verein, N. V., and Ozerova, G. A. The Mechanism of Formation of Radicals During the Photolysis of Frozen Ethanolic Solutions of Triphenylamine at 77°K. *Dokl. Akad. Nauk SSSR* 154, 910 (1964).
107. Poutsma, Marvin L. Competition Between Ionic and Free-Radical Reactions During Chlorination of Cyclohexene. Spontaneous Generation of Radicals. *J. Am. Chem. Soc.* 85, 3511 (1963).
108. Ramirez, Fausto, McKelvie, N., and Desal, N. B. The Phosphoranyl Free Radical,  $R_3(X)P^\cdot$ . Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 57-1-3 (1961).
109. Razuvayev, G. A., Abakumov, G. A., and Pestunovich, V. A. The Structure of the Protonated Ion-Radical of Tetraphenylhydrazine. *Zh. Strukt. Khim.* 5, 307 (1964).
110. Razuvayev, G. A., Etlis, V. S., and Smirnov, A. N. Electron Paramagnetic Resonance Spectra of Ion-Radicals Formed in Oxidation-Reduction Reactions of 5-Thioxanthenol Dioxide. *Zh. Obshch. Khim.* 33, 3749 (1963).
111. Razuvayev, G. A., Kirillov, A. I., and Etlis, V. S. Thermal Decomposition of Bis(1-methylpercarbonatocyclohexyl) Peroxide. *Ibid.*, 131 (1963).
112. Reimlinger, Hans, Golstein, Jean Pierre, Jadot, Josef, and Jung, Paul. Preparation of Symmetrical Tetraarylethanes and Their Dissociation Into Radicals. *Ber.* 97, 349 (1964).
113. Research Institute for Medicine and Chemistry, Inc. Acyl Radicals. French Patent 1,360,782, May 15, 1964.
114. Rieche, A., Elschner, B., and Landbeck, M. Dinaphthoxyls as Stable Aroxyl Radicals. *Angew. Chem.* 72, 385 (1960).

115. Rooney, J. J., and Pink, R. C. Formation and Stability of Hydrocarbon Radical-Ions on a Silica-Alumina Surface. *Trans. Faraday Soc.*, 58, 1632 (1962).
116. Rozantsev, E. G., and Neiman, M. B. Organic Radical Reactions Involving no Free Valence. *Tetrahedron* 20, 131 (1964).
117. Rozantsev, E. G., and Papko, R. A. 2,2,7,7-Tetra-methyl-5-oxohomopiperazine N-Oxide, A New Stable Free Radical. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 2254 (1962).
118. Rozantsev, E. G., and Shapiro, A. B. A New Stable Free Radical of the Indole Class - 2,2,4,4-Tetramethyl-1,2,3,4-tetrahydro- $\gamma$ -carbolin-3-oxyl. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1123 (1964).
119. Rozantsev, E. G., Medzhidov, A. A., and Neiman, M. B. Kinetically Stable Radicals of the Pyrrole Series. *Ibid.*, 1876 (1963).
120. Rundel, W., and Scheffler, K. A Stable Radical From 2,4,6-Tri-tert-butylthiophenol. *Z. Naturforsch.* 18b, 984 (1963).
121. Russell, Glen A., and Janzen, Edward G. Formation of Free Radicals From Benzyl-Type Carbanions in the Presence of Unsaturated Organic Substances. *Am. Chem. Soc., Div. Petrol. Chem., Preprints* 7, C81 (1962).
122. Russell, Glen A., and Janzen, Edward G. Reactions of Resonance Stabilized Anions. III. Spontaneous Formation of Radical Anions From Nitro Aromatics in Basic Solution. *J. Am. Chem. Soc.* 84, 4153 (1962).
123. Russell, Glen A., Janzen, Edward G., and Strom, Thomas. Reactions of Resonance Stabilized Anions. V. The Formation of Radical-Anions by Electron Transfer Between Anions and Their Unsaturated Analogs in Dimethyl Sulfoxide Solution. *Ibid.*, 4155 (1962).
124. Russell, Glen A., Moye, Anthony J., and Nagpal, K. L. Reactions of Resonance Stabilized Anions. IV. Effect of Structure on the Rate of Reaction of Carbanions With Molecular Oxygen. *Ibid.*, 4154 (1962).
125. dos Santos-Veiga, J. Evidence for the Formation of the Tropyl Radical in Liquid Solution. *Mol. Phys.* 5, 639 (1962).

126. Schmidt, Ulrich, and Mueller, Asmus. Organic Sulfur Radicals. II. Isolation of the Phenylthio Radical. *Angew. Chem.* 75, 299 (1963).
127. Schmidt, Ulrich, Kabitzke, Karlheinz, and Markau, Klaus. Organic Sulfur Radicals. VIII. Phenoxythion Radical Ions. *Ber.* 97, 498 (1964).
128. Schmidt, Ulrich, Kabitzke, Karlheinz, Markau, Klaus, and Mueller, Asmus. Organic Sulfur Radicals. III. Organic Sulfur Radical Ions (Sulfinium Salts). *Ann.* 672, 78 (1964).
129. Schmidt, Ulrich, Kabitzke, K. H., and Markau, K. Organic Sulfur Radicals. VII. o-Nitrophenylsulfonylimine Radical. *Angew. Chem.* 76, 376 (1964).
130. Schmidt, Ulrich, Mueller, Asmus, and Markau, Klaus. Organic Sulfur Radicals. V. Arylsulfur Radicals, Benzylsulfur Radical, and Phenylselenium Radical. *Tetrahedron Letters*, 1091 (1963).
131. Schmidt, Ulrich, Mueller, Asmus, and Markau, Klaus. Organic Sulfur Radicals. VI. Isolation of Arylsulfur Radicals Benzylsulfur, and Phenylselenium Radicals. *Ber.* 97, 405 (1964).
132. Schueler, H. Existence of Biradicals in Glow Discharge Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 62-1-62-3 (1961).
133. Schular, Robert H. Production of Methyl Radicals in the Recoil Chemistry of Carbon-11. *J. Phys. Chem.* 68, 1618 (1964).
134. Shapiro, A. B., Rozantsev, E. G., Povarov, L. S., and Grigos, V. I. A New Stable Free Radical: 4-Methyl-2-spirocyclohexyl-3,4:3',-2'-tetrahydrofuran-1,2,3,4-tetrahydroquinolin-1-oxyl. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1725 (1964).
135. Shine, H. J., and Piette, L. Ion-Radicals. The Reaction of Thioaromatic Compounds With Acids. II. Diphenyl Disulfide, Thianthrene, and Thianthrene Oxides. *J. Am. Chem. Soc.* 84, 4793 (1962).
136. Stashkov, L. I., and Matevosyan, R. O. Chemistry of Free Radicals of Hydrazine Series. XIV. Synthesis of  $\alpha,\alpha$ -Di( $\alpha$ -naphthyl)- $\beta$ -picrylhydrazine and  $\alpha,\alpha$ -Di( $\beta$ -naphthyl)- $\beta$ -picrylhydrazyl. *Zh. Obshch. Khim.* 34, 137 (1964).

137. Tabushi, Twao, Ide, Toru, and Oda, Ryhei. Formation of Acetoxy Radical in the Reactions of Acetic Anhydride With Reducing Agents. *Nippon Kagaku Zasshi* 84, 984 (1963).
138. Takamura, Tsutoma, and Kashiqakura, Jiro. The Free Radical of Quinone Formed on Active Alumina. *Bull. Chem. Soc. Japan* 36, 1538 (1963).
139. Tanner, Dennis D. Polar Radicals. I. Succinimide Radicals Generated From N-iodosuccinimide. *J. Am. Chem. Soc.* 86, 4674 (1964).
140. Tench, A. J., and Coppens, P. Free Radicals Formed From 0-Substituted Nitro Compounds. *J. Phys. Chem.* 67, 1378 (1963).
141. Thomson, R. H., and Wylie, A. G. Persulfate Oxidation of (Aromatic) Carboxylic Acids: A New Rearrangement. *Proc. Chem. Soc.*, 65 (1963).
142. Tomita, Masao, Ueda, Shinichi, Nakai, Yasuto, Deguchi, Yasho, and Takaki, Hideo. Cation Radicals of Dibenzo-p-dioxin and Related Compounds. *Tetrahedron Letters*, 1189 (1963).
143. Trenwith, A. B. The Thermal Decomposition of Acetaldehyde: The Formation of Hydrogen. *J. Chem. Soc.*, 4426 (1963).
144. Tautsui, Minoru, and Chang, George. Element Organic Compounds. VI. Significance of  $\pi$ -Radical Hybridization: New Synthetic Method for Bio-Arene  $\pi$ -Complexes. *Can. J. Chem.* 41, 1255 (1963).
145. Tudos, Ferenc, Heidt, Janos, and Ero, Janos. Chemistry of Free Radicals. III. Synthesis and Investigation of Certain Free Radicals of the Danfield Type. *Magy. Kem. Folyoirat* 70, 329 (1964).
146. Vartanyan, L. S., Strigun, L. M., and Emanuel, N. M. Kinetics of the Autoxidation of Propyl Gallate in Aqueous Solution. *Dokl. Akad. Nauk SSSR* 148, No. 1, 97 (1963).
147. Walter, Robert I. Preparation and Physical Properties of Stable Organic Free Radicals. US Dept. Com., Office Tech. Serv., PB Rept. 154,498, 63 pp. 1960.

148. Wang, Chi-Hua, Levine, Philip L., and Parsons, Harry G. Reduction of Triethyllead Cation. A Novel Method to Generate Ethyl Radicals. *Tetrahedron Letters*, 687 (1964).

149. Windle, J. J., Wiersma, A. K., and Tappel, A. L. Free Radicals From Se and S Antioxidants. *Nature* 203, 404 (1964).

150. Zandstra, P. J. Electron Spin Resonance of Cyclopentadienyl. *J. Chem. Phys.* 40, 612 (1964).

151. Zweig, Arnold, and Hoffmann, A. Kentaro. Chemistry of Dianions. II. Anion Radical and Dianion of Diethyl Azodicarboxylate. *J. Am. Chem. Soc.* 85, 2736 (1963).

152. Zweig, A., Hodgson, W. G., Jura, W. H., and Maricle, D. L. Sulfur Analog of Wurster's Blue Cation Radical. *Tetrahedron Letters*, 1821 (1963).

#### REACTIONS OF FREE RADICALS.

153. Abramovitch, R. A., and Saha, J. G. Aromatic Substitution. III. Reaction of Pyridine With Ortho-Substituted Phenyl Radicals, and the Influence of Oxygen Upon Isomer Ratios in the Gomberg-Hey Reaction. *J. Chem. Soc.*, 2175 (1964).

154. Anderson, Kenneth H., and Benson, Sidney. Catalytic Transfer by HCl in the Pyrolysis of Neopentane. The Rate of Dissociation of the Neopentyl Radical. *J. Chem. Phys.* 40, 3747 (1964).

155. Ang, How-Ghee, Huang, R. L., and Simi, Hooi-Guat. The Reaction of Some Alkyl Benzyl and Benzyl Cycloalkyl Ethers With tert-Butoxy Radicals. *J. Chem. Soc.*, 4841 (1963).

156. Avramenko, L. I., and Kolesnikova, R. V. Kinetics and the Mechanism for the Reaction of the  $\text{CH}_2\text{OH}$  Radical With a Molecule of Oxygen. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 591 (1961).

157. Azatyan, V. V., Nalbandyan, A. B., and Oganesyan, K. T. Reaction of Oxygen Atoms With Methyl Alcohol. *Dokl. Akad. Nauk SSSR* 157, 930 (1964).

158. Badger, G. M., and Whittle, C. P. Reaction of Naphthyl Radicals With Naphthalene. *Australian J. Chem.* 16, 440 (1963).

159. Bagdasar'yan, Kh. S., and Revzin, A. F. Determination of Absolute Rate Constants of Radical Reactions. I. Addition of Trichlorobromomethane to Cyclohexene and 1-Heptene. *Kinetika i Kataliz* 4, 844 (1963).
160. Bamford, C. H., Blackie, M. S., and Finch, C. A. Stereoregulation in the Free Radical Polymerization of Polar Monomers. *Chem. Ind. (London)*, 1763 (1962).
161. Bass, K. C. Hydrogen Abstraction by Benzyl Radicals. *Nature* 201, 700 (1964).
162. Bauer, R. H., and Coppinger, G. M. Chemistry of Hindered Phenols. Reactivity of 2,6-Di-tert-butyl-4-methylphenoxy. *Tetrahedron* 19, 1201 (1963).
163. Bazilevskii, M. V. Reaction of Phenyl Radicals With the Hydrogen Atoms of the Methyl and Phenyl Group. *Zh. Fiz. Khim.* 38, 225 (1964).
164. Bazilevskii, M. V., and Bagdasar'yan, Kh. S. Quantitative Studies of the Reactivity of Radicals by the Method of Competing Reactions. Reactions of the Phenyl Radical With Phenol, Aniline, and Anisole. *Kinetika i Kataliz* 5, 215 (1964).
165. Beckwith, A. L. J., and Leydon, R. J. Mechanism of the Reaction of Ferrocene With Free Radical Reagents. *Tetrahedron Letters*, 385 (1963).
166. Bell, T. N., Pullman, B. J., and West, B. O. Reactions of Perfluoroalkyl Radicals With Metals. *Australian J. Chem.* 16, 722 (1963).
167. Berezin, I. V., and Martinek, Karel. Reactivity of Cyclohexyl and Heptyl Free Radicals in Liquid-Phase Reactions With C-T Bonds of Some Hydrocarbons (Effect of Conjugation). *Zh. Fiz. Khim.* 38, 998 (1964).
168. Berlin, A. A., and Vonsyatskii, V. A. Induced Reactivity of Some Compounds With a Conjugated System in the Reaction With 1,1-Diphenyl-2-picrylhydrazyl. *Dokl. Akad. Nauk SSSR* 154, 627 (1964).
169. Berson, Jerome A., Olsen, Carl J., and Walia, Jasjit Singh. Reactions of the 2-Bornyl Radical. II. A Free Radical Wagner-Meerwein Rearrangement. *J. Am. Chem. Soc.* 84, 3337 (1962).

170. Bonner, William A., and Mango, Frank D. Rearrangement of the 1,2,2-Triphenylethyl Radical. *J. Org. Chem.* 29, 29 (1964).
171. Boozer, Charles E., Love, Clifton B., Motes, John M., Turner, Robert, Toney, Jewell, Maxey, Bobby G., Christian, W. W., and Stevens, W. W., Jr. Reaction of Alkylperoxy Radicals. US Dept. Com., Office Tech. Serv., PB Rept. 154, 949, 15 pp. 1959.
172. Bothner-By, A. A., Krapcho, A. P., and Van der Veen, J. M. Reactions of Aromatics Containing an Added Extra Electron. Am. Chem. Soc., Div. Petrol. Chem. Preprints 4, No. 4, B17-B30 (1959).
173. Bidger, Robert Frederick. Directive Effects in Abstraction Reactions of the Phenyl Radical. *Dissertation Abstr.* 24, 71 (1963).
174. Bridger, Robert F., and Russell, Glen A. Directive Effects in Aliphatic Substitution. XXIII. Directive Effects in the Attack of Phenyl Radicals on Carbon-Hydrogen Bonds. *J. Am. Chem. Soc.* 85, 3754 (1963).
175. Brown, A. C. R., and James, D. G. L. Kinetic Study of the Addition of Ethyl Radical to Conjugated Dienes. *Proc. Chem. Soc.*, 81 (1962).
176. Buchachenko, A. L., Neiman, M. B., Sukhanova, O. P., and Mamedova, Yu. G. Effect of Solvents on the Reactivity of Nitrophenols of Different Structures With the Tri-tert-butylphenoxy Radical. *Zh. Fiz. Khim.* 37, 221 (1963).
177. Buchachenko, A. L.; Sdobnov, E. I., Rafikov, S. R., and Neiman, M. B. The Reactivity of Diethyl Phosphite in Radical Reactions With Tri-tert-butylphenoxy. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk.* 1118 (1963).
178. Bugaenko, L. T., and Byakov, V. M. A New Method for Evaluating the Ratio of the Rate Constants in Reactions Between Radicals and Their Acceptors. *Dokl. Akad. Nauk SSSR* 158, 186 (1964).
179. Buley, A. L., and Norman, R. O. C. Organic Radicals as Electron Donors in Solution. *Proc. Chem. Soc.*, 225 (1964).

180. Burkley, Isabel B., and Rebbert, R. E. Reactions of Methyl Radicals With Aromatic Compounds. I. Toluene, Ethylbenzene, and Cumene. *J. Phys. Chem.* 67, 168 (1963).
181. Buxton, George, and Wilmarth, W. K. Aqueous Chemistry of Inorganic Free Radicals. V. Carbon Monoxide as a Scavenger for Hydroxyl Radicals Generated by the Photolysis of Hydrogen Peroxide. *Ibid.*, 2835 (1963).
182. Byakov, V. M., and Ershler, B. V. Data on the recombination of Radicals From Different Tracks During Radiolysis at High-Irradiation Intensities. III. Concentration Range and Irradiation Rates for Which the Simplified Radiolysis Model is Valid. *Zh. Fiz. Khim.* 37, 2016 (1963).
183. Cain, Audley Llewellyn. Orientation and Reactivity in Aromatic Free Radical Substitution. Attack by p-Tolyl Radicals on anisole and Nitrobenzene. *Dissertation Abstr.* 24, 507 (1963).
184. Cerfontain, H. Radical-Induced Oxidation of Acetaldehyde. *Rec. Trav. Chim.* 83, 919 (1964).
185. Champ, Antony E. The Reaction of Thiyl and Alkoxy Radicals With 4-Vinylcyclohexene. *Dissertation Abstr.* 24, 967 (1963).
186. Cher, Mark. Reaction of Methyl Radicals in Toluene. *J. Phys. Chem.* 68, 1316 (1964).
187. Cher, Mark. The Liquid Phase Reaction of Methyl Radicals With Methanol. *Ibid.* 67, 605 (1963).
188. Corbett, G. E., and Williams, Gareth H. Reactions of Alkyl Radicals. I. The Methylation of Benzene, Fluorobenzene, Chlorobenzene, and Bromobenzene With Methyl Radicals Formed by the Photolysis of Methylmercuric Iodide. *J. Chem. Soc.*, 3437 (1964).
189. Cristol, Stanley J., and Davies, David I. Bridged Polycyclic Compounds. XXV. Free-Radical Addition of Benzenesulfonly Halides to Norbornadiene. *J. Org. Chem.* 29, 1282 (1964).
190. Cristol, Stanley J., Gaston, Lyle K., and Tiedeman, Trent. Bridged Polycyclic Compounds. XXIV. The Halogenation of Substituted Norbornyl Radicals. *Ibid.*, 1279 (1964).

191. Current, J. H., and Rabinovitch, B. S. Decomposition of Chemically Activated Ethyl-d<sub>3</sub> Radicals. Primary Intramolecular kinetic Isotope Effect in a Nonequilibrium System. *J. Chem. Phys.* 38, 783 (1963).
192. Current, J. H., Rabinovitch, B. S., Heller, C. A., and Gordon, A. S. Decomposition of Chemically Activated Ethyl-d<sub>1</sub> Radicals. *Ibid.* 39, 3535 (1963).
193. Davies, D. I. Free-Radical Addition Reactions in Solution. *J. Leeds Univ. Union Chem. Soc.* 4, 19 (1962).
194. Degani, Jacopo, Tiecco, Marcello, and Tundo, Antonio. Homolytic Reactions. VI. Reactions Between Diaryl Disulfides and benzyl Radicals. *Gazz. Chim. Ital.* 92, 1213 (1962).
195. De la Mare, Harold E., Kochi, Jay K., and Rust, Frederick F. The Oxidation and Reduction of Free Radicals by Metal Salts. *J. Am. Chem. Soc.* 85, 1437 (1963).
196. Del Greco, Frank P., and Kaufman, Frederick. Lifetime and Reactions of OH Radicals in Discharge-Flow Systems. Discussions Faraday Soc. No. 33, 128 (1962).
197. Denney, Donald B., and Weiss, Hilton M. Reactions of Triphenylmethyl With Peroxides. *J. Org. Chem.* 28, 1415 (1963).
198. Dietrich, M. W., and Wahl, A. C. Nuclear Magnetic Resonance (N.M.R.) Studies of Electron Transfer Between Tris(2,2'-dipyridyl)osmium(II) and -(III) Ions, Between Bis(cyclopentadienyl)iron(II) and -(III) Ions, and Between Tris(1,10-phenanthroline)iron(II) and -(III) Ions. *J. Chem. Phys.* 38, 1591 (1963).
199. Dixon, P. S., and Szwarc, M. Reactions of CF<sub>3</sub> Radicals in the Gaseous and Liquid Phases. Effect of Solvent Upon the Rate Constants. *Trans. Faraday Soc.* 59, 112 (1963).
200. Doepper, Richard D., and Ausloos, P. Gas-Phase Photolysis of Methyl Iodide. Reactions of Hot Methyl Radicals With Added Organic Compounds. *J. Chem. Phys.* 41, 1865 (1964).
201. Dominey, D. A., and Danby, C. J. The Reaction of Methyl Radicals With Propene. *J. Chem. Soc.*, 4656 (1962).

202. D'yakonov, I. A., Nizovkina, T. V., and Grebenkina, V. M. Addition of Carbethoxycarbene Radical to Chloroprene. *Zh. Obshch. Khim.* 32, 3450 (1962).

203. Engelhard, Herman, Breuer, George, and Froben, Friedrich Wilhelm. Reactions of H Atoms and OH Radicals in Aqueous Systems. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 71-1-5 (1961).

204. Ermolaev, V. K., Molin, Yu. N., and Buben, Ya. Recombination of Radicals in Organic Solids. I. Investigation by Melting. *Kinetika i Kataliz* 3, 58 (1962).

205. Ermolaev, V. K., Molin, Yu. N., and Buben, Ya. Recombination of Radicals in Organic Solids. II. Kinetic Regularities. *Ibid.*, 314 (1962).

206. Ermolaev, V. K., Molin, Yu. N., and Buben, N. Ya. Recombination of Radicals in Some Frozen Organic Compounds. *Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow*, 331 (1960).

207. Farenhorst, E., and Kooymen, E. C. The Interaction of Free Radicals and Aromatics. III. The Kinetics of the Addition of Cyanoisopropyl and Trichloromethyl Radicals to Anthracene Derivatives. *Rec. Trav. Chim.* 81, 816 (1962).

208. Ferdinandi, E. S., Garby, W. P., and James, D. G. L. The Reactivity of the Cyclic Polyenes Towards Free Radicals. I. Copolymerization With Acrylonitrile. *Can. J. Chem.* 42, 2568 (1964).

209. Freidlina, R. Kh., Aminov, S. N., and Terent'ev, A. B. Rearrangement of Radicals in the Process of Telomerization of Ethylene With Acetic Acid. *Dokl. Akad. Nauk SSSR* 156, 1133 (1964).

210. Gal, Peter. The Reactivity of the Triphenylcyclopropenyl Free Radical. Rearrangements of Substituted Cyclopropenyl Dimers to Substituted Benzenes. *Dissertation Abstr.* 23, 2693 (1963).

211. Garst, John F., and Cole, Ronald S. Reactivity of Phenyl Radicals Toward Aromatic Solvents on "Cage" Phenylation by Phenylazo(triphenyl)methane. *Tetrahedron Letters*, 679 (1963).

212. Gill, D., Jagur-Grodzinski, J., and Szwarc, M. Chemistry of Radical Ions: Electron-Transfer Reactions. "DD" + Dimethylanthracene and "DD" + Pyrene. *Trans. Faraday Soc.* 60, 1424 (1964).

213. Gordon, A. S. Some Reactions of Cycloalkyl Radicals. *Pure Appl. Chem.* 5, 441 (1962).

214. Gowenlock, Brian G., and Snelling, David R. The Reactions of Alkyl-Substituted Amino Radicals. *Advan. Chem. Ser.* 36, 150 (1962).

215. Gitter, Roy J., and Albers, Robert J. Structure of a 1-Substituted Cyclohexyl Free Radical. *J. Org. Chem.* 27, 4708 (1962).

216. Gitter, Roy J., Sabatino, Edward, and Sacharow, Stanley. Transannular Reactions of Free Radicals. US Dept. Com., Office Tech. Serv., PB Rept., 150, 407, 45 pp. 1960.

217. Hanes, Maurice H., and Bair, Edward J. Reactions of Nitrogen-Hydrogen Radicals. I. NH<sub>2</sub> Recombination in the Decomposition of Ammonia. *J. Chem. Phys.* 38, 672 (1963).

218. Hendry, Dale G., and Russell, Glen A. Directive Effects in Aliphatic Substitutions. XXVI. Solvent Effects in the Reactions of Free Radicals and Atoms. 9. Effect of Solvent Polarity on the Reactions of Peroxy Radicals. *J. Am. Chem. Soc.* 86, 2368 (1964).

219. Hendry, Dale G., and Russell, Glen A. Directive Effects in Aliphatic Substitutions. XXVII. Retarding Effects of Polyarylimethanes in Autoxidation Reactions. *Ibid.*, 2371 (1964).

220. Hershenson, Harold, and Benson, Sidney W. Decomposition of the Tert-Butoxy Radical; Evidence for Pressure Dependence. *J. Chem. Phys.* 37, No. 8, 1889 (1962).

221. Hoffmann, A. Kentaro, Feldman, Allan M., Gelblum, Ernestine, and Hodgson, William G. Mechanism of the Formation of Di-tert-butyl Nitroxide From Tert-Nitrobutane and Sodium. *J. Am. Chem. Soc.* 86, 639 (1964).

222. Hoffmann, A. Kentaro, Hodgson, William G., Maricle, Donald L., and Jura, Walter H. Cleavage Reactions of Tertiary Nitro Anion Radicals. *Ibid.*, 631 (1964).

223. Hogg, A. M., and Kebabc, Paul. Addition of Methyl Radicals to Vinyl Chloride and Catalysis of Di-tert-butyl Peroxide Decomposition by Chlorinated Compounds. *Ibid.*, 4558 (1964).
224. Holmes, J. L., and Kutschke, K. O. Reactions of Trifluoromethyl Radicals With Benzene and Toluene. *Trans. Faraday Soc.*, 58, 333 (1962).
225. Horner, Leopold, and Anders, Bertram. Studies on the Course of Substitution. XXII. The Polar and Radical Course of the Reaction of Diacetyl Peroxide With Primary, Secondary, and Tertiary Amines, and With Phosphines, Arsine, Thioethers, and Ethers. *Ber.*, 95, 2470 (1962).
226. Huang, R. L., and Lee, Kheng H. Reactions of  $\alpha$ -Methoxy- and  $\alpha$ ,  $\alpha$ -Dimethoxybenzyl Radicals. *Tetrahedron Letters*, 711 (1963).
227. Illingworth, George Ernest. Addition of Free Radicals to Allenes. *Dissertation Abstr.*, 24, 973 (1963).
228. Ingold, K. U., The Effect of Substituents on the Relative Rates of Reaction of Tert-Butoxy Radicals With Phenols in Carbon Tetrachloride and in Chlorobenzene. *Can. J. Chem.*, 41, 2816 (1963).
229. Ingold, K. U. The Reaction of Tert-Butoxy Radicals With 2,6-Di-tert-butyl-4-methylphenol and 2,6-Di-tert-butylphenol. *Ibid.*, 2807 (1963).
230. Jackson, R. A. Kinetics of Free-Radical Reactions in Solution. I. Evaluation of Rate Constants for Transfer Reactions in Systems With Varying Radical Concentrations. *J. Chem. Soc.*, 5281 (1963).
231. Jackson, R. A. Kinetics of Free-Radical Reactions in Solution. II. The Reaction of Benzylic Radicals With Substituted Toluenes. *Ibid.*, 5284 (1963).
232. Jackson, W. M., McNesby, J. R., and Darwent, B. deB. Reaction of Methyl-d<sub>3</sub> Radicals With Isobutane, Isobutane-2-d, and Propane. *J. Chem. Phys.*, 37, 1610 (1962).
233. Jackson, W. M., McNesby, J. R., and Darwent, B. deB. Thermal Reactions of Isobutyl Radicals. *Ibid.*, 2256 (1962).

234. Johnson, P. S., and Water, William A. The Quantitative Study of the Arylation of Naphthalene by Means of Diazonium Salts and Zinc. II. J. Chem. Soc., 4652 (1962).
235. Kaufman, F., and Del Greco, F. P. Fast Reactions of OH Radicals. Symp. (Intern.) Combust., 9th, Cornell Univ., Ithaca, N. Y., 659 (1962).
236. Kazanskii, V. B., Parilskii, G. B., Aleksandrov, I. V., and Zhidomirov, G. M. Electron Paramagnetic Resonance Study of Free-Radical Interaction With a Solid Surface (Silica Gel). Fiz. Tverd. Tela 5, 649 (1963).
237. Kazarnovskii, I. A., Lipikhin, N. P., and Kozlov, S. V. Reaction of Free Hydroxyl Radicals and Oxygen With Acetic Acid Vapor. Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, 956 (1963).
238. Kheruze, Yu. I., and Petrov, A. A. Addition of Triphenylmethyl Radicals to Divinylacetylene and Its Homologs. Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol. 6, 170 (1963).
239. Kice, John L., and Cantrell, Thomas S. The Formation of a 1,3,6-Cyclooctatriene by 1,4-Radical Addition to Cyclooctatetraene and Its Intramolecular Isomerization to a Bicyclo(4.2.0)octa-2,4-diene. J. Am. Chem. Soc. 85, 2298 (1963).
240. Komazawa, H., Stefani, A. P., and Szwarc, M. Irreversibility of  $\text{CF}_3$  Addition. Reactions With Some Cis and Trans Isomers and the Problem of Cis-Trans Isomerization. Ibid., 2043 (1963).
241. Kooijman, Eduard C. Addition and Abstraction Reactions Involving Trichloromethyl Radicals. Tetrahedron 19, Suppl. No. 2, 415 (1963).
242. Kooijman, Eduard C. Steric Effects in Some Free Radical Reactions. Record Chem. Progr. 24, 93 (1963).
243. Krause, Alfons. On the Catalytic Oxidation of NO. Chemiker Ztg. 87, 156 (1963).
244. Kutschke, K. O. Reaction of Perfluoroalkyl Radicals With Molecular Hydrogen. Can. J. Chem. 42, 1232 (1964).

245. Lamb, Robert C., and Pacifici, Jas. Grady. Organic Peroxides. III. Behavior of Cyclohexaneformyl Peroxide in the Presence of Excess Stable Radicals. Simultaneous Determination of Kinetics and Free Radical Efficiencies in the Thermal Decompositions of Free Radical Initiators. *J. Am. Chem. Soc.* 86, 914 (1964).

246. Landbeck, M. Binaphthoxyls, Radicals With Univalent Oxygen. *Monatsber. Deut. Akad. Wiss. Berlin* 3, 657 (1961).

247. Larkin, F. S., and Thrush, B. A. Heterogeneous Recombination of Free Atoms. *Nature* 197, 375 (1963).

248. Lebedev, Ya. S., Ermolaev, V. K., Tzvetkov, Yu. D., Molin, Yu. N., Buben, N. Ya., and Voevodskii, V. V. Recombination of Radicals in the Condensed Phase. Preprints Papers Intern. Symp. Free Radicals. 5th, Uppsala, 37/1-11 (1961).

249. Le Goff, P., Cassuto, A., and Pentenero, A. Recombination of Atoms and Free Radicals Upon Contact With Solids. *Ind. Chim. Belge* 29, 342 (1964).

250. Long, Joyce, and Skirrow, G. Reactions of Alkyl Radicals. III. Reaction of Methyl Radicals With Diethyl Ether. *Trans. Faraday Soc.* 58, 1403 (1962).

251. Lynch, Brian M., and Chang, H. S. Free Radical Phenylations of 1-Methyldiazoles. *Tetrahedron Letters*, 617 (1964).

252. McNesby, J. R., and Jackson, W. M. Isomerization of Isobutyl Radicals. *J. Chem. Phys.* 38, 692 (1963).

253. Magat, M. Reactions of Organic Radicals in the Solid State Between 90 and 273°K. *Pure Appl. Chem.* 5, 487 (1962).

254. Mahoney, L. R. Reactions of Peroxy Radicals With Polynuclear Aromatic Compounds. I. Reactivities of Anthracene,  $\alpha$ -Benzanthracene, and Tetracene Toward Alkyl Aryl Peroxy Radicals. *J. Am. Chem. Soc.* 86, 444 (1964).

255. Martin, Michael M., and Gleicher, Gerald Jay. The Addition of the Trichloromethyl Radical to  $\omega$ -Phenyl-Alkenes. *Ibid.*, 238 (1964).

256. Martin, Michael M., and Gleicher, Gerald Jay. The Addition of the Trichloromethyl Radical to Substituted 3-Phenyl-1-propenes and 4-Phenyl-1-butenes. *Ibid.*, 233 (1964).
257. Martinez, F., Wojtowicz, J. A., and Zaslawsky, J. A. Characterization of H Superoxides in Frozen Matrixes. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 42-1-42-21 (1961).
258. Maschke, A., Shapiro, B. S., and Lampe, F. W. Mechanism of the Low-Temperature Scavenging of Methyl-d<sub>3</sub> Radicals by NO. *J. Am. Chem. Soc.*, 85, 1876 (1963).
259. Maschke, A., Shapiro, B. S., and Lampe, F. W. Reaction of Methyl Radicals With Nitric Oxide. *Ibid.*, 86, 1929 (1964).
260. Matevosyan, R. O., and Ikrina, M. A. Chemistry of Free Radicals of the Hydrazine Series. IX. Synthesis of α,α-Diphenyl-β-2,6-dinitro-4-carboxyphenylhydrazyl and α,α-Diphenyl-β-2,6-dinitro-4-bromo-phenylhydrazyl. *Zh. Obshch. Khim.*, 33, 499 (1963).
261. Matsuoka, M., Dixon, P. S., Stefani, A. P., and Szwarc, M. Structure of the Transition State in the Disproportionation and Combination of Ethyl Radicals. *Proc. Chem. Soc.*, 304 (1962).
262. Matteson, D. S., and Peacock, Kenneth. Dibutyl Acetyleneboronate: Preparation and Some Additions of Free Radicals. *J. Org. Chem.*, 28, 369 (1963).
263. Metcalfe, Eileen L., and Trotman-Dickenson, A. F. The Reactions of Alkyl Radicals. XI. The Absolute Rate of Isopropyl Combination. *J. Chem. Soc.*, 4620 (1962).
264. Minisci, Francesco, and Galli, Remo. New Syntheses by Amino Radicals From N-Chloramines in the Presence of Olefins and Oxidation-Reduction Systems. *Tetrahedron Letters*, 167 (1964).
265. Minisci, Francesco, and Galli, Remo. Reactivity of Hydroxy and Alkoxy Radicals in Presence of Olefins and Oxidation-Reduction Systems. Introduction of Azido, Chloro, and Alkoxy Groups in Allylic Position and Azido Chlorination of Olefins. *Ibid.*, 357 (1963).

266. Minisci, Francesco, Galli, Remo, and Cecere, Mirella. New Syntheses by Means of Addition of Alkyl and Aryl Radicals to Acrylonitrile in the Presence of Oxidation-Reduction Systems. Oxidation and Reduction of  $\alpha$ -Cyanoalkyl Radicals. *Chim. Ind.* 46, 1064 (1964).
267. Miyagawa, Ichiro, and Ito, Koichi. Exchange of Hydrogen Atoms of Free Radicals in Irradiated Organic Solids. *Proc. Intern. Symp. Mol. Struct. Spectry.*, Tokyo, 4 pp. (1962).
268. Mkryan, G. M., and Mnzhoyan, Sh. L. Reactions of Ethers With Unsaturated Radicals. II. Investigation of 1,4 Cleavage of Ethers With Butyn-2-yl Radicals. *Izv. Akad. Nauk Arm. SSR, Khim. Nauki* 17, 306 (1964).
269. Mueller, Eugen, Rieker, Anton, and Schick, Anton. Dehydrogenation-Addition-Reactions With Aroxyl Radicals. I. New Syntheses of Aryl Alkyl Ethers, Aryl Esters, Quinol Ethers, and  $\beta$ -Hydroxybiphenyl Esters Proceeding by Radical Mechanisms. *Ann.* 673, 40 (1964).
270. Mulcahy, M. F. R., and Williams, D. J. Reaction of Phenoxy Radicals With Methyl Radicals in the Gaseous Phase. *Nature* 199, 761 (1963).
271. Muzychenko, L. A. Preferential Direction of Free-Radical Reactions. *Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol.* 6, 243 (1963).
272. Nair, S., and de Sousa, J. B. Alkoxy Radicals. II. Reaction of the Benzyloxy Radical With Inhibitors: Iodine. *J. Chem. Soc.*, 4464 (1962).
273. Neiman, M. B., Rozantsev, E. G., and Mamedova, Yu. G. A New Organic Radical Reaction Involving no Free Valence. *Nature* 200, 256 (1963).
274. Nelson, Lee E., Angeletti, Nicholas C., and Weyenberg, Donald R. The Free Radical-Catalyzed Disproportionation of Arylsilanes. A New Homolytic Aromatic Displacement Reaction. *J. Am. Chem. Soc.* 85, 2662 (1963).
275. Osugi, Jiro, Sato, Masanori, and Sasaki, Muneo. Reaction of Diphenylpicrylhydrazyl With Free Radicals Formed by Photolysis of Azobis(isobutyronitrile). *Nippon Kagaku Zasshi* 85, 307 (1964).

276. Phillips, L., and Shaw, R. The Gas-Phase Reaction of Chlorine Monoxide With Hydrocarbons: Chlorination by the ClO<sup>•</sup> Radical. Proc. Chem. Soc. 294 (1962).
277. Pokhodenko, V. D., and Ganyuk, L. M. Oxidation of the 2,6-Di-tert-amyl-4-methylphenoxy Free Radical. Dopovid Akad. Nauk Ukr. RSR, No. 1, 73 (1963).
278. Pokhodenko, V. D., Ganyuk, L. M., and Brodskii, A. I. Radicals, Products of Thermal Decomposition of Substituted Cyclohexanone Peroxide. Dokl. Akad. Nauk SSSR 149, 321 (1963).
279. Pratt, G. L., and Purnell, J. H. Gas-Phase Reactions of Ethyl Radicals With Nitric Oxide. Trans. Faraday Soc. 60, 371 (1964).
280. Pritchard, G. O., Hsia, Y. P., and Miller, G. H. Radical Recombination Reactions. III. Methyl and Heptafluoro-n-propyl Radicals. J. Am. Chem. Soc. 85, 1568 (1963).
281. Pryor, William A. Reaction of Radicals. A Comparison of Peroxides and Disulfides. Tetrahedron Letters, 1201 (1963).
282. Pryor, William A., and Guard, Harold. Walden Inversion by Radicals. Reaction of Phenyl Radicals With Disulfides. J. Am. Chem. Soc. 86, 1150 (1964).
283. Pryor, William A., and Kaplan, Gerald L. Reactions of Radicals. X. Butyl Peroxide. Ibid., 4234 (1964).
284. Pryor, William A., and Platt, Paul K. Reactions of Radicals. V. Reaction of Phenyl Radicals With Aliphatic Disulfides. Ibid., 1496 (1963).
285. Pryor, William A., and Pultinas, Edmund P., Jr. Reactions of Radicals. II. The Rates of the Spontaneous and Induced Decomposition of Propyl Peroxide. Ibid., 133 (1963).
286. Pryor, William A., Huston, D. M., Fiske, T. R., Pickering, T. L. and Cluffarin, E. Reactions of Radicals. XI. Ethyl Peroxide, Isopropyl Peroxide and Sec-Butyl Peroxide. Ibid. 86, 4237 (1964).

287. Pryor, William A., Lee, Alice, and Witt, C. E. Reactions of Radicals. IX. Tert-Butyl Peroxide. *Ibid.*, 4229 (1964).
288. Putirskaya, G. B., and Matus, I. Quantitative Determination of Free Radicals Produced in the Radioanalysis of Water With the Aid of a Stable Free Radical. *Acta Chim. Acad. Sci. Hung.* 38, 249 (1963).
289. Quinn, C. P. Isomerization of Primary n-Alkyl Radicals in the Pyrolysis of Ethane. *Trans. Faraday Soc.* 59, 2543 (1963).
290. Rabani, Joseph, and Stein, Gabriel. Reactivity of OH Radicals With Ferro-Ferricyanide, Formate, Ethanol, and Amino Acids in Irradiated Solutions. *Ibid.* 58, 2150 (1962).
291. Razuvayev, G. A., and Boguslavskaya, L. S. Synthesis With Free Hydroxyl Radicals. III. Reaction of Alkyl Acetates With Hydroxyl Radicals. *Zh. Obshch. Khim.* 32, 2320 (1962).
292. Rebbet, R. E., and Ausloos, P. The Reaction of Methyl Radicals With Dimethylmercury. *J. Am. Chem. Soc.* 86, 2068 (1964).
293. Reutov, O. A. Rearrangements of Free Alkyl Radicals and Alkyl Cations in Solution. *Pure Appl. Chem.* 7, 203 (1963).
294. Rieker, Anton, Mueller, Eugen, and Beckert, Werner. Aroxyls as Electron Acceptors—Their Behavior Towards Grignard Compounds. *Z. Naturforsch.* 17b, 718 (1962).
295. Roebber, John L. The Oxidation of Methyl Radicals at Liquid-Helium Temperature. *J. Phys. Chem.* 67, 2391 (1963).
296. Roquette, B. C., and Wijnen, M. H. J. Recombination and Disproportionation Reactions of Monochloroethyl and Trichloromethyl Radicals. *J. Chem. Phys.* 38, 4 (1963).
297. Rosenblatt, David H., Hayes, Albert J., Jr., Harrison, Bernice L., Streaty, Richard A., and Moore, Kenneth A. Reaction of Chlorine Dioxide With Triethylamine in Aqueous Solution. *J. Org. Chem.* 28, 2790 (1963).
298. Rozantsev, E. G. Reactions of a New Organic Radical Which do not Affect the First Valence. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1669 (1963).

299. Rozantsev, E. G., and Papko, R. A. The Beckmann Rearrangement of a Free Radical. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 764 (1963).

300. Rozantsev, E. G., Mamedov, Yu. G., and Neiman, M. B. Preservation of the Open Valence in Reduction of the Free Radical of 2,2,6,6-Tetramethyl- $\gamma$ -piperidone N-oxide by the Kishner Method. *Ibid.*, 2250 (1962).

301. Rozantsev, E. G., Neiman, N. B., and Mamedova, Yu. G. Reaction of a Free Organic Radical With a Grignard Reagent. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1509 (1963).

302. Russell, G. A., and Bridger, Robert F. Thermal Decomposition of Phenylazotriphenylmethane. *Tetrahedron Letters*, 737 (1963).

303. Russell, Glen A., and Bridger, Robert F. The Reactivity of Phenyl Radicals Toward Molecular Oxygen. *J. Am. Chem. Soc.* 85, 3765 (1963).

304. Russell, Glen A., and Hendry, Dale G. Solvent Effects in Reactions of Free Radicals and Atoms. VII. Solvent Effects in Reactions of Methylenes. *J. Org. Chem.* 28, 1933 (1963).

305. Russell, Glen A., and Williamson, Roger C., Jr. Directive Effects in Aliphatic Substitutions. XXIV. Nature of the Polar Effect in Reactions of Atoms and Radicals. 2. Reactions of Chlorine Atoms and Peroxy Radicals. *J. Am. Chem. Soc.* 86, 2357 (1964).

306. Russell, Glen A., and Williamson, Roger C., Jr. Directive Effects in Aliphatic Substitutions. XXV. Reactivity of Aralkanes, Aralkenes, and Benzylic Ethers Toward Peroxy Radicals. *Ibid.*, 2364 (1964).

307. Russell, Glen A., Ito, Akihiko, and Hendry, Dale G. Solvent Effects in the Reactions of Free Radicals and Atoms. VIII. The Photochlorination of Aralkyl Hydrocarbons. *Ibid.* 85, 2976 (1963).

308. Sabatino, Edward Charles. Free Radical Reactions of Oxiranes and a Thiirane. *Dissertation Abstr.* 24, 4408 (1964).

309. Salomon, Mark. Isotope Effects in Methyl Radical Abstraction Reactions. *Can. J. Chem.* 42, 610 (1964).

310. Sanders, William A., and Rebbert, R. E. Reactions of Methyl Radicals With Aromatic Compounds. II. Xylenes. *J. Phys. Chem.* 67, 170 (1963).
311. Schmidt, Ulrich, and Mueller, Asmus. Organic Sulfur Radicals. IV. Opening of the Disulfide Bridge by Cyanoisopropyl Radicals. Estimation of Disulfides in the Presence of Thio Ethers, Nitriles, Amines, and Solvents. *Ann.* 672, 90 (1964).
312. Schwetlick, K., Jentzsch, J., Karl, R., and Wolter, D. Reactions With Tert-Butoxy Radicals. III. Dehydrodimerizations With Di-Tert-Butyl Peroxide. *J. Prakt. Chem.* 25, 95 (1964).
313. Schwetlick, K., Karl, R., and Jentzsch, J. Reactions With Tert-Butoxy Radicals. I. The Reactivity of Aliphatic and Araliphatic Compounds Towards Tert-Butoxy Radicals. *Ibid.* 22, 113 (1963).
314. Schwetlick, Klaus, and Pietzsch, Ulrike. Reactions With Tert-Butoxy Radicals. II. Reactivity of Aromatic Compounds Toward Tert-Butoxy Radicals. *Ibid.* 25, 125 (1964).
315. Shannon, T. W., and Harrison, A. G. The Reaction of Methyl Radicals With Methyl Alcohol. *Can. J. Chem.* 41, 2455 (1963).
316. Sherwood, Alden G., and Gunning, Harry E. Reactions of Unsaturated Free Radicals With Nitric Oxide. Radical-Induced Scission of Carbon-Carbon Triple Bonds. *J. Am. Chem. Soc.* 85, 3506 (1963).
317. Simons, J. P., and Yarwood, A. J. Decomposition of Hot Radicals. I. Production of  $\text{CCl}$  and  $\text{CBr}$  From Halogen-Substituted Methyl Radicals. *Trans. Faraday Soc.* 57, 2167 (1961).
318. Solon, Emanuel, and Bard, Allen J. Coulometric Study of the Reaction of Diphenylpicrylhydrazyl and Bromide Ion. *J. Phys. Chem.* 68, 1144 (1964).
319. Sood, Satya, Pal. The Reactivity of Polynuclear Aromatic Hydrocarbons Toward Styryl Radicals. *Dissertation Abstr.* 25, 137 (1964).
320. Stefani, A. P., and Szwarc, M. Addition of  $\text{CF}_3$  Radicals to Aromatic Hydrocarbons. The Relative Selectivity of  $\text{CF}_3$ . *J. Am. Chem. Soc.* 84, 3661 (1962).

321. Stepukhovich, A. D., and Ulitskii, V. A. Steric Factors in the Reactions of Recombination and Disproportionation of Radicals and Their Formation From Molecules. *Zh. Fiz. Khim.* 35, 2569 (1961).
322. Suama, Masakazu, and Takezaki, Yoshimasa. Reaction of Methyl Radicals With Dimethyl Disulfide. *Bull. Inst. Chem. Res., Kyoto Univ.* 40, 229 (1962).
323. Sunner, S. Thermochemistry of Selected Radical Recombination Reactions. US Dept. Com., Office Tech. Serv., AD 274, 252, 11 pp. 1962.
324. Symons, M. C. R. Relation Between Stereochemistry and Reactivity of Organic Free Radicals. *Nature* 198, 1196 (1963).
325. Szwarc, M., Evans, F. W., Fox, R. J., Feld, M., and Stefani, A. P. Abstraction of Halogen Atoms by Methyl Radicals. US Dept. Com., Office Tech. Serv., AD 405, 045, 35 pp. 1963.
326. Szwarc, M., Herk, L., Feld, M. Cage Reactions. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, B1-1-24 (1961).
327. Takemoto, Kiichi. Chemistry of Addition of Methyl Free Radicals, With Special Reference to the Work of Szwarc, et al. *Kagaku* 16, 748 (1961).
328. Terao, Terumi, and Shida, Shoji. Reactions of Methylene Radicals With Benzene and Toluene in the Gas Phase. *Bull. Chem. Soc. Japan* 37, 687 (1964).
329. Terao, Terumi, Sakai, Nobuyoshi, and Shida, Shoji. Reaction of Methylenes Radicals With Acetylene in the Gas Phase. *J. Am. Chem. Soc.* 85, 3919 (1963).
330. Thynne, J. C. J. Reactions of Alkyl Radicals. II. Methyl Radical Photosensitized Decomposition of Propyl and Isopropyl Formates. *Trans. Faraday Soc.* 58, 1394 (1962).
331. Thynne, J. C. J. Reactions of Alkyl Radicals. III. Methyl-Radical-Sensitized Decomposition of Butyl Formate. *Ibid.*, 1533 (1962).
332. Thynne, J. C. J. Reactions of Methyl Radicals With Primary Amines. *Proc. Chem. Soc.*, 145 (1963).

333. Thynne, J. C. J., and Gray, Peter. Methoxyl-Radical-Induced Decomposition of Methyl Formate: Kinetics of Methoxyl and Methyl Radical Reactions. *Trans. Faraday Soc.*, 59, 1149 (1963).

334. Thynne, J. C. J., and Gray, Peter. Methyl-Radical-Sensitized Decomposition of Gaseous Dimethyl Carbonate. *Ibid.* 58, 2403 (1962).

335. Thynne, J. C. J., and Gray, Peter. The Reaction of Methoxy Radicals With Methyl Formate; Comparisons Between Alkoxy and Alkyl. *Proc. Chem. Soc.*, 295 (1962).

336. Toby, S., and Weiss, B. H. Third-Body Effects in the Combination of Methyl Radicals. *J. Phys. Chem.* 68, 2492 (1964).

337. Tomkinson, D. M., Galvin, J. P., and Pritchard, H. O. Abstraction of Chlorine Atoms by Methyl Radicals. *Ibid.*, 541 (1964).

338. Trosman, E. A., and Bagdasar'yan, Kh.S. Quantitative Study of Reactions of the Phenyl Radical With Aromatic Compounds. *Zh. Fiz. Khim.* 38, 141 (1964).

339. Tuleen, D. L., Bentruude, W. G., and Martin, J. C. Anchimerically Accelerated Bond Homolysis. III. Polar and Geometric Factors Influencing the Radical Decompositions of Tert-butyl-o-phenyl-thioperbenzoate. *J. Am. Chem. Soc.* 85, 1938 (1963).

340. Ung, A. Y. M., and Back, R. A. Photolysis of Water Vapor and Reactions of Hydroxyl Radicals. *Can. J. Chem.* 42, 753 (1964).

341. Val'kovskii, D. G., Sosin, S. L., and Korshak, V. V. Decomposition of Tertiary Butyl Peroxide and the Reactions of the resulting Radicals in the Synthesis of Poly(diphenylmethylene). *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1319 (1963).

342. van der Ploeg, H. J., Knotnerus, J., and Bickel, A. F. Free Radical Reactions of Allene. The Interaction of Allene and Thiyl Radicals. *Rec. Trav. Chim.* 81, 775 (1962).

343. Vitry-Raymond, Jacqueline, and Metzger, Jacques. Experimental and Theoretical Study of the Reactivity of Thiazole and 4,5-Dimethylthiazole Towards Free Phenyl and Substituted Phenyl Radicals. *Bull. Soc. Chim. France*, 1784 (1963).

344. Vol'kenshtein, F. F., Gorban, A. N., and Sokolov, V. A. Recombination Processes of Free Radicals on the Surface of Semiconductors and Their Role in Luminescence. *Kinetika i Kataliz* 4, 24 (1963).

345. Vorobev, Vladimir, Lefort, Daniel, Sorba, Janine, and Rouillard, Denise. Higher Aliphatic Peracids. VII. Decomposition of Perlauric Acid in the Presence of Diphenylpicrylhydrazyl. *Bull. Soc. Chim. France*, 1577 (1962).

346. Wagner, Peter John, Jr. The Fate of Alkoxy Radicals as Determined by the Medium in Which They are Generated. *Dissertation Abstr.* 25, 857 (1964).

347. Whitney, George Stephen. The Stereochemistry of the Free Radical Addition of Thiolacetic Acid to Cyclic Olefins. *Ibid.* 23, 3134 (1963).

348. Whittemore, I. M., Stefani, A. P., and Szwarc, M. Addition of  $\text{CF}_3$  Radicals to Substituted Benzenes. *J. Am. Chem. Soc.* 84, 3799 (1962).

349. Wunderlich, Francis J., and Rebbert, R. E. The Reactions of Methyl Radicals With Aromatic Compounds. III. The Fluorotoluenes. *J. Phys. Chem.* 67, 1382 (1963).

350. Yang, Kang. Chemical Reactivity and Bond Interaction. *J. Chem. Phys.* 38, 2586 (1963).

351. Yang, Kang. Free Radical Reactions Initiated by Ionizing Radiations. III. Paraffin Reactivities in Hydrogen Atom Abstraction Reactions. *J. Phys. Chem.* 67, 562 (1963).

352. Yoshida, Zenichi, Matsumoto, Toshihiko, and Oda, Ryohei. Free Radical Reactions. VIII. Direct Ring Amination of Anthraquinone- $\beta$ -sulfonic Acid With Amino Free Radicals. *Kogyo Kagaku Zasshi* 67, 67 (1964).

353. Yoshida, Zenichi, Matsumoto, Toshihiko, and Oda, Ryohei. Free Radical Reactions. IX. Direct Ring Amination of Anthraquinone With Amino Free Radicals. *Ibid.*, 70 (1964).

354. Zavgorodnii, V. S., and Petrov, A. A. Addition of Triphenylmethyl Radicals to 1,3-Enynic Stanno hydrocarbons. *Dokl Akad. Nauk SSSR* 149, 846 (1963).

REACTIONS THROUGH FREE RADICAL MECHANISMS.

355. Abramovitch, R. A., Hymers, W. A., Rajan, J. B., and Wilson, R. Aromatic Substitution. IV. Thermal Decomposition of Diazonium Salts. Evidence for the Formation of Radical Intermediates. *Tetrahedron Letters*, 1507 (1963).

356. Adams, John Q., and Nicksic, Stephen W. Free Radicals in Friedel-Crafts Reactions. *J. Am. Chem. Soc.* 84, 4355 (1962).

357. Afanas'ev, I. B., and Beer, A. A. Telomerization of Bromochloromethane With Ethylene. *Zh. Vses. Khim. Obshchestva im. D. I. Mendeleva* 7, 595 (1962).

358. Allen, J. C., Cadogan, J. I. G., Harris, B. W., and Hey, D. H. Synthetic Aspects of Free-Radical Addition. I. Radical-Alkylation of Malonic Ester and Related Compounds. *J. Chem. Soc.*, 4468 (1962).

359. Anderson, Kenneth Howard. Free Radical Processes in the Dimethyl Ether Decomposition and in the Chlorine-Oxygen Systems. *Dissertation Abstr.* 24, 3551 (1964).

360. Applequist, Douglas E., and Scarle, Roger. Synthesis, Brominolysis, and Pyrolysis of a "Dewar" Anthracene. A Free Radical Displacement on Carbon. *J. Am. Chem. Soc.* 86, 1389 (1964).

361. Asscher, Meir, Levy, Edmond, and Vofsi, David. A Novel Initiating System for the Telomerization of Ethylene and Carbon Tetrachloride. *Atti Congr. Intern. Materie Plastiche* 12, 151, 216 (1960).

362. Badger, G. M., Kimber, R. W. L., and Novotny, J. Formation of Aromatic Hydrocarbons at High Temperatures. XXI. Pyrolysis of n-Butylbenzene Over a Range of Temperatures From 300° to 900° Intervals. *Australian J. Chem.* 17, 778 (1964).

363. Bailey, Wm. J., and Hirsch, Stephen S. Preparation of 2-Bromo-3-methylbutane by the Radical Addition of Hydrogen Bromide to 2-Methyl-2-butene. *J. Org. Chem.* 28, 2894 (1963).

364. Bartlett, Paul D., and Gortler, Leon B. Peresters. XI. Di-tert-butyl Diphenylperoxymalonate. α-Lactone Intermediates in Free Radical Reactions. *Ibid.*, 1854 (1963).

365. Bartlett, Paul D., and Minato, Hiroshi. Peresters. X. Tert-Butyl Peroxychloroformate. *J. Am. Chem. Soc.* 85, 1858 (1963).

366. Bartlett, Paul D., Montgomery, Lawrence K., and Seidel, Bernhard. Cycloaddition. I. The 1,2-Addition of 1,1-Dichloro-2,2-difluoroethylene to Some Dienes. *Ibid.* 86, 616 (1964).
367. Beckwith, A. L. J., and Leydon, R. J. Free-Radical Phenylation of Ferricenium Ion. *Ibid.*, 952 (1964).
368. Beckwith, A. L. J., and See, Low Beng. Thiyil Radicals. III. Some Reactions of Anthracene, 1,2-Benzanthracene, and 3,4-Benzo-pyrene With Thiols and Oxygen. *Australian J. Chem.* 17, 109 (1964).
369. Bohm, Bruce A., and Abell, Paul I. Stereochemistry of Free Radical Additions to Olefins. *Chem. Rev.* 62, 599 (1962).
370. Brace, Neal O. Cyclization to a Five-Membered Ring in the Free-Radical of Iodoperfluoroalkanes With 1,6-Heptadiene. *J. Am. Chem. Soc.* 86, 523 (1964).
371. Brace, Neal O. 1-Iodo-2-(perfluoroalkyl)cycloalkanes by the Free Radical Addition of Iodoperfluoroalkanes to Cyclohexane and Cyclopentene. *J. Org. Chem.* 28, 3093 (1963).
372. Brois, Stanley J. Mechanism of Reaction of Nitric Oxide With Trialkylboranes. *Tetrahedron Letters*, 345 (1964).
373. Chauviere, Gerard, Vetter, Walter, and Zoltan. Mechanism of Action of Grignard Reagents. Reduction of Deuterated  $\alpha$ -Aminonitriles. *Compt. Rend.* 258, 4287 (1964).
374. Chernyak, B. I., and Kucher, R. V. The Mechanism of the Liquid Phase Oxidation of 1-Butene. *Neftekhimiya* 4, 576 (1964).
375. Chiang, Ming-Chien, and Li, Shen. A Quantitative Relation Between Molecular Structure and Chemical Reactivity. II. The Addition Reaction of Alkenes and Diethyl Malonate. *Hua Hsueh Hsueh Pao.* 30, 176 (1964).
376. Clifford, A. A., and Waters, William A. Oxidations of Organic Compounds by Cupric Salts. III. The Oxidation of Propargyl Alcohol. *J. Chem. Soc.*, 3056 (1963).
377. Cram, Donald J., and Dalton, Cecile K. Studies in Stereochemistry. XXXVI. Radical Anions as Neighboring and Electron Transfer Groups in Substitution-Reduction Reactions. *J. Am. Chem. Soc.* 85, 1268 (1963).

378. Cullis, C. F., and Persht, E. The Slow Combustion of Isopentane. Combust. Flame 7, 353 (1963).
379. Cullis, C. F., Fish, A., and Trimm, D. L. Alkyl-peroxy Radical Rearrangements During the Gaseous Oxidation of Isobutane. Proc. Roy. Soc. (London) Ser. A 273, 427 (1963).
380. De la Mare, H. E., and Coppinger, G. M. Oxidation of N,N-dialkylhydroxylamines With Tert-Butyl Hydroperoxide. A New Synthesis for Nitrones. J. Org. Chem. 28, 1068 (1963).
381. Delone, I. O., Osityanskaya, L. Z., and Petrov, Al. A. Migration of Alkyl Radicals in Some Benzene and Naphthalene Homologs. Neftekhimiya 2, No. 2, 189 (1962).
382. Denisov, E. T. Formation of Free Radicals in the System RH + O<sub>2</sub>. I. Tetralin, Cyclohexanol, Cyclohexanone. Kinetika i Kataliz 4, 53 (1963).
383. Denisov, E. T., and Solyanikov, V. M. Mechanism of the Liquid-Phase Oxidation of Isopropanol. Neftekhimiya 4, 458 (1964).
384. Dixon, W. T., and Norman, R. O. C. An Intermediate in Homolytic Aromatic Substitution. Proc. Chem. Soc., 97 (1963).
385. Dowbenko, R. Free Radical, Transannular Cycloadditions to Cis, cis-1,5-cyclooctadiene. Tetrahedron 20, 1843 (1964).
386. Dowbenko, Rostyslaw. Free-Radical Cycloadditions to Cis, cis-1,5-cyclooctadiene. J. Am. Chem. Soc. 86, 946 (1964).
387. Dolog, L. Proof of the Primary Reaction in the Autoxidation of Tetralin. Makromol. Chem. 77, 206 (1964).
388. Dulou, Raymond, Chretien-Bessiere, Yvonne, and Desalbres, Henri. Radical Cyclization of  $\alpha$ -Campholenic Aldehyde. Compt. Rend. 258, 603 (1964).
389. D'yachkovskii, F. S., and Shilov, A. E. Mechanism of the Reaction of Ethyllithium With Ethyl Iodide. Zh. Obshch. Khim. 33, 406 (1963).

390. Eargle, Dolan H., Jr. Cleavage of Aryl Ethers by Alkali Metals in Aliphatic Ether Solvents. Detection by Electron Spin Resonance. *J. Org. Chem.* 28, 1703 (1963).

391. Eberhardt, G. G., and Butte, W. A. A Catalytic Telomerization Reaction of Ethylene With Aromatic Hydrocarbons. *Ibid.* 29, 2928 (1964).

392. Eisch, John J., and Thompson, Robert M. Chemistry of Alkali Metal-Unsaturated Hydrocarbon Adducts. II. Radical-Anion Intermediates in the Metal Reductions of Aza-Aromatic Heterocycles. *Ibid.* 27, 4171 (1962).

393. Elad, Dov., and Rokach, Joshua. The Light-Induced Amidation of Terminal Olefins. *Ibid.* 29, 1855 (1964).

394. Eliel, E. L., Eberhardt, M., Simamura, O., and Meyerson, S. Mechanisms of Free Radical Aromatic Substitution. *Tetrahedron Letters*, 749 (1962).

395. Evans, Alwyn G., and Phillips, B. D. Electron Transfer Reactions Involving N-benzohydrylideneaniline. *Chem. Ind. (London)*, 1718 (1964).

396. Farnia, G., Giacometti, G., Talamini, G., and Vianello, E. Relative Reactivities of OH Radical Additions to Ethylenic Compounds in Aqueous Solutions. *Chim. Ind. (Milan)* 45, 1327 (1963).

397. Fish, A. Radical Rearrangement in Gas-Phase Oxidation and Related Processes. *Quart. Rev. (London)* 18, 243 (1964).

398. Freidlina, R. Kh., and Terent'ev, A. B. Homolytic Isomerization of Acetone Butyl Thioketal. *Dokl. Akad. Nauk SSSR* 152, 637 (1963).

399. Freidlina, R. Kh., Terent'ev, A. B., and Petrova, R. G. Radical Isomerization of Acetophenone Diphenylmercaptole. *Ibid.* 151, 866 (1963).

400. Galiba, I., Tedder, J. M., and Watson, R. A. Free-Radical Substitution in Aliphatic Compounds. V. Halogenation of 1,1,1-Trifluoropentane. *J. Chem. Soc.*, 1321 (1964).

401. Gavigan, James J. Radical-Catalyzed Reactions of Diallylphenylphosphine Oxide and Ethyl Diallylphosphinate With Chain Transfer Solvents. *Dissertation Abstr.* 23, 3120 (1963).

402. George, Susan, and Ittyerah, P. I. Malonanilic Acid Hydrazide as a Reagent for Carbonyl Compounds. *Agra Univ. J. Res.* 12, 77 (1963).

403. Gerdil, R., and Lucken, E. A. C. Action of Alkali Metals on Organic Sulfur Compounds. I. The Cleavage of Thioanizole by Potassium in Ethereal and Hydrocarbon Solvents. *J. Chem. Soc.*, 2857 (1963).

404. Goldwhite, H., and Harris, C. Free-Radical Addition Reactions of Alkane Sulfonyl Halides. *Chem. Ind. (London)*, 1721 (1962).

405. Goldwhite, H., Gibson, M. S., and Harris, C. Free Radical Addition Reactions. I. The Reaction of Tri-, Di-, and Mono-chloromethanesulfonyl Chlorides With Alkenes. *Tetrahedron* 20, 1613 (1964).

406. Goldwhite, H., Gibson, M. S., and Harris, C. Free Radical Addition Reactions. II. Reaction of Trichloromethanesulfonyl Chloride With Styrene and Chemistry of the Adducts. *Ibid.*, 1649 (1964).

407. Goldwhite, H., Gibson, M. S., and Harris, C. Free Radical Addition Reactions. III. Route to  $\gamma$ -Chloro and  $\gamma$ -Hydroxycarboxylic Acid Derivatives. *Ibid.*, 1657 (1964).

408. Greene, Frederick D., Savitz, Maxine L., Osterholz, Frederick D., Lau, Hans H., Smith, William N., and Zanet, Paul M. Decomposition of Tertiary Alkyl Hypochlorites. *J. Org. Chem.* 28, 55 (1963).

409. Greene, Frederick D., Stein, Harvey P., Chu, Chin-Chiun, and Vane, Floie M. Mechanisms of Decomposition of Diacyl Peroxides. *J. Am. Chem. Soc.* 86, 2080 (1964).

410. Griesbaum, Karl, Oswald, Alexis A., Quiram, Ernest R., and Naegle, Walter. Allene Chemistry. I. Free Radical Addition of Thiols to Allene. *J. Org. Chem.* 28, 1952 (1963).

411. Gritter, Roy J., and Woosley, Royce S. Peroxide-Induced Free-Radical Addition of Acetamide to Oct-1-ene. *J. Chem. Soc.*, 5544 (1963).
412. Gromov, S. I., and Kataev, G. A. Reaction of Zinc With Mixtures of Carbon Tetrachloride and Methanol. *Tr. Tomskogo Gos. Univ. Ser. Khim.*, 154, 128 (1962).
413. Hanson, John Elbert. Some Free Radical Reactions of Organosilicon Compounds. *Dissertation Abstr.*, 25, 818 (1964).
414. Harris, J. F., Jr., and Stacey, F. W. Free Radical Addition of Hydrogen Sulfide to Fluoroethylenes. *J. Am. Chem. Soc.*, 85, 749 (1963).
415. Hassal, C. H., and Scott, A. I. The Intramolecular Free Radical Coupling of Phenols. *Proc. Plant Phenolics Group Symp.*, 3, 119 (1960).
416. Herberman, Sheldon. Reactions of Tert-Butyl Peroxide With Grignard Reagents. *Dissertation Abstr.*, 24, 3096 (1964).
417. Hey, D. H., Perkins, M. J., and Williams, Gareth H. Mechanisms of Free-Radical Aromatic Substitution. *Tetrahedron Letters*, 445 (1963).
418. Hey, D. H., Shingleton, D. A., and Williams, Gareth H. Photolytic Formation and Reactions of Aralkyl Radicals. *J. Chem. Soc.*, 1958 (1963).
419. Hoare, D. G., and Waters, William A. Oxidations of Organic Compounds by Cobaltic Salts. IV. Kinetic Product Studies of Oxidations of Tertiary Alcohols. *Ibid.*, 2552 (1964).
420. Hoare, D. G., and Waters, William A. Oxidations of Organic Compounds by Cobaltic Salts. V. Kinetic and Product Studies, and Isotope Effects in the Oxidation of Secondary Alcohols. *Ibid.*, 2560 (1964).
421. House, Herbert O., and Kramar, Vera. The Chemistry of Carbanions. I. The Reaction of Triphenylmethane With Potassium. *J. Org. Chem.*, 27, 4146 (1962).

422. Huisgen, Rolf, and Zahler, Wolf Dieter. Ionic and Radical Mechanisms of the Intramolecular Arylation via Diazo Compounds. *Ber.* 96, 736 (1963).

423. Huyser, Earl S., and Bredeweg, Corwin J. Induced Decompositions of Di-tert-butyl Peroxide in Primary and Secondary Alcohols. *J. Am. Chem. Soc.* 86, 2401 (1964).

424. Huyser, Earl S., and Taliaferro, J. Dale. Effect of Remotely Positioned Groups on the Reactivities of Olefins Toward Radical Addition. *J. Org. Chem.* 28, 1676 (1963).

425. Huyser, Earl S., and Taliaferro, J. Dale. Free-Radical Additions to 2-Cyclopropylpropene. *Ibid.* 34, 442 (1963).

426. Huyser, Earl S., and Wang, Dorothy T. Reactions of Mixed Acetals With Di-tert-butyl Peroxide. *Ibid.* 29, 2720 (1964).

427. Jagur-Grodzinski, J., and Szwarc, M. Chemistry of Radical Ions-Kinetics of Decomposition of Complexes of Anthracene and Living Dimer of  $\alpha$ -Methylstyrene. *Trans. Faraday Soc.* 59, 2305 (1963).

428. Julia, Marc, and James, Claude. Radical Cyclization of  $\epsilon$ - and  $\zeta$ -Acetylenic Cyano Esters. *Compt. Rend.* 255, 959 (1962).

429. Kalvoda, Jaroslav, Hausler, Karel, Meystre, Charles, Wieland, Peter, Amer, Georg, and Wettstein, Albert. Stereochemistry of Free-Radical, Intramolecular Reactions. *Gazz. Chim. Ital.* 93, No. 1-2, 140 (1963).

430. Karpukhin, O. N., Shlyapintokh, V. Ya., and Mikhailov, I. D. Chemiluminescence and the Rate of Elementary Reactions in the Cooxidation of Cumene and Ethylbenzene. *Zh. Fiz. Khim.* 38, 156 (1964).

431. Kaz'min, S. D. Oxidation of Acetophenone Initiated by Peroxidic Compounds. *Zh. Obshch. Khim.* 33, 282 (1963).

432. Kerber, Robert C., Urry, Gran W., and Kornblum, Nathan. Radical Anions as Intermediates in Substitution Reactions. Carbon Alkylation of Nitroparaffin Salts. *J. Am. Chem. Soc.* 86, 3904 (1964).

433. Kochi, Jay K. Co-reductions With Alkali Metals. I. Styrene and Acetone With Sodium. *J. Org. Chem.* 28, 1960 (1963).

434. Kochi, Jay K. Co-reductions With Alkali Metals. II. The Co-reduction of Conjugated Dienes and Carbonyl Compounds. *Ibid.*, 1969 (1963).

435. Koenig, T. W., and Martin, J. C. Enchimerically Accelerated Bond Homolysis. IV. Participation of a Neighboring Olefinic Double Bond in the Decomposition of a Tert-Butyl Perester. *J. Org. Chem.* 29, 1520 (1964).

436. Komori, Saburo, Okahara, Mitsuo, and Harada, Yasumasa. Chlorination of Long-Chain Alkylamines. I. Reaction of Saturated Long-Chain Alkylamines With Chlorine in Hydrochloric Acid. *Kogyo Kagaku Zasshi* 66, 1850 (1963).

437. Komori, Saburo, Okahara, Mitsuo, and Omatu, Hirokazu. Chlorination of Long-Chain Alkylamines. II. Free-Radical Chlorination of Long-Chain Alkylamines in Concentrated Hydrochloric Acid. *Ibid.*, 67, 327 (1964).

438. Kost, V. N., Vasil'eva, T. T., and Freidlina, R. Kh. Radical Isomerization in the Process of Dimerization of 3, 3, 3-Trichloropropene. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 1254 (1962).

439. Kost, V. N., Vasil'eva, T. T., and Freidlina, R. Kh. Radical Rearrangement in the Process of Dimerization of 3-Fluoro-3, 3-dichloropropene and 3-Fluoro-<sup>2</sup> 3, 3-trichloropropene. *Dokl. Akad. Nauk Belorussk. SSR* 7, 538 (1963).

440. Kramer, Walter E., and Joo, Louis A. Nitrogen-Containing Epoxy Resins. US Patent 3, 056, 763, October 2, 1962.

441. Laidler, K. J., and McKenney, D. J. Kinetics and Mechanisms of the Pyrolysis of Diethyl Ether. I. The Uninhibited Reaction. *Proc. Roy. Soc. (London) Ser. A* 278, 505 (1964).

442. Laidler, K. J., and McKenney, D. J. Kinetics and Mechanisms of the Pyrolysis of Diethyl Ether. II. The Reaction Inhibited by Nitric Oxide. *Ibid.*, 517 (1964).

443. Lalande, Robert, and Cazaux, Michel. Radical Addition of Acetone and Ethyl Acetoacetate to  $\beta$ -Pinene. *Compt. Rend.* 258, 4567 (1964).

444. Lavrov, N. V., and Petrenko, I. G. The Mechanism of the Reactions of Conversion of Methane by Carbon Dioxide. Dokl. Akad. Nauk SSSR 157, 1410 (1964).

445. Lawesson, Sven Olov, and Gronwall, Susanne. Peroxy Compounds. VI. A Novel Method for the Preparations of Acyloins. Acta Chem. Scand. 14, 1445 (1960).

446. Lemaire, H., and Rassat, A. Radical Intermediates in the Oxidation of Nitrogen Derivatives by Lead Tetraacetate. Tetrahedron Letters, 2245 (1964).

447. Litkovets, A. K., and Yurzhenko, T. I. The Rate of Thermal Decomposition of Unsaturated Organosilicon Peroxides. Dokl. Akad. Nauk SSSR 154, 679 (1964).

448. Little, William F., Lynn, Kay N., and Williams, Roland. A Novel Side Reaction Accompanying the Arylation of Ferrocene. An Example of Free Radical Substitution. J. Am. Chem. Soc. 85, 3055 (1963).

449. Loury, Maurice. A Double Radical Mechanism of the Autoxidation of Aldehydes With an Aliphatic Chain. Compt. Rend. 258, 238 (1964).

450. McCall, E. B., Neale, A. J., and Rawlings, T. J. Derivatives of Dibenzofuran and Dibenzothiophene. I. Monophenyl Derivatives. J. Chem. Soc., 4900 (1962).

451. McCall, E. B., Neale, A. J., and Rawlings, T. J. Derivatives of Dibenzofuran and Dibenzothiophene. II. Free Radical Phenylation of Dibenzothiophene. Ibid., 5288 (1962).

452. McDowell, C. A., and Sifniades, S. Oxygen-18 Tracer Evidence for the Termination Mechanism in the Photochemical Oxidation of Acetaldehyde. Can. J. Chem. 41, 300 (1963).

453. McGrath, B. P., and Tedder, J. M. Free-Radical Substitution in Aliphatic Compounds. IV. The Reaction of Trichloromethyl Radicals With Propane, Butane, and Isobutane. Bull. Soc. Chim. Belges 71, 772 (1962).

454. Mango, Frank Donald. Free-Radical Rearrangements. The Decarbonylation of 2, 3, 3-Triphenylpropionaldehyde. The Electrolytic Decarboxylation of 3, 3-Diphenylpropionic Acid. *Dissertation Abstr.* 24, 3099 (1964).
455. Markgraf, J. Hodge, Brown, Hamilton B., Jr., Mohr, Scott C., and Peterson, Richard G. The Rearrangement of Pyridine N-oxide With Acetic Anhydride: Kinetics and Mechanism. *J. Am. Chem. Soc.* 85, 958 (1963).
456. Maruyama, Kazuhiro. Appearance of Free Radicals During Grignard Reactions. *Bull. Chem. Soc. Japan* 37, 897 (1964).
457. Mayo, Frank R. Free Radical Additions of Hydrogen Chloride to Alkenes. *J. Am. Chem. Soc.* 84, 3964 (1962).
458. Mayo, Frank R., Durham, Lois J., and Griggs, Kyle S. The Reaction of Alkanes With Phosphorus Trichloride and Oxygen. *Ibid.* 85, 3156 (1963).
459. Minisci, Francesco. Radical Reactivity of N-chloro-amines. Mechanism of the Ferrous Chloride-Catalyzed Hofmann-Löffler Reaction. *Chim. Ind. (Milan)* 46, 57 (1964).
460. Minisci, Francesco, and Galli, Remo. Free Carbon .m Radicals. Oxidation by Ligand Transfer or Electron Transfer and Affinity to Conjugated Olefins. *Ibid.* 45, 448 (1963).
461. Minisci, Francesco, Galli, Remo, and Cecere, Mirella. New Radical Processes in Presence of Oxidation-Reduction Systems. Direct Introduction of Azido Groups. *Gazz. Chim. Ital.* 94, 67 (1964).
462. Montgomery, Lawrence K., Schueller, Kathleen, and Bartlett, Paul D. Cycloaddition. II. Evidence of a Biradical Intermediate in the Thermal Addition of 1, 1-Dichloro-2, 2-difluoroethylene to the Geometrical Isomers of 2, 4-Hexadiene. *J. Am. Chem. Soc.* 86, 622 (1964).
463. Morrison, Robert T., Cazes, Jack, Samkoff, Norman, and Howe, Charles A. Validity of Rate Factors in Free Radical Aromatic Substitution. *Ibid.* 84, 4152 (1962).

464. Nelson, Robert L., Bell, Jerry A., Norland, Kenneth, and Linschitz, Henry. Interactions Between Excited Molecules and Metal Ions: The Catalysis of Radiationless Transitions in Oxazine Dyes by Heavy Metal Ions and Complexes. Proc. Intern. Symp. Mol. Struct. Spectry., Tokyo, 2 pp. (1962).

465. Neumann, Wilhelm P., Niermann, Horst, and Sommer, Pichard. Organotin Compounds. III. Radical-Catalyzed Synthesis of Tin Alkyls From Olefins and Organotin Hydrides. Ann. 659, 27 (1962).

466. Nielsen, Arnold T., Moore, Donald W., Mazur, Judith Heitz, and Berry, Kristin Highberg. Thermal Cleavage of 1,1'-Diacetyl-1,1',4,4'-tetrahydro-4,4'-bipyridine. J. Org. Chem. 29, 2898 (1964).

467. Nikiforov, G. A., and Dyumaev, K. M. Inhibitors of Free Radical Reactions. V. Synthesis of 3,5-Dialkyl-4-hydroxyphenylalanines. Izv. Akad. Nauk SSSR, Ser. Khim., 1068 (1964).

468. Nikishin, G. I., and Vorob'ev, V. D. Free Radical Addition of Low-Molecular-Weight Alcohols to Unsaturated Compounds. Ibid., 894 (1964).

469. Nikishin, G. I., Mustafaev, R. I., and Petrov, A. D. Free Radical Addition of Chloroacetic Acid and Its Methyl Ester to  $\alpha$ -Olefins. Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, 359 (1963).

470. Nikishin, G. I., Mustafaev, R. I., and Petrov, A. D. Free Radical Addition of N-alkylacetamides to Methyl Acrylate. Dokl. Akad. Nauk SSSR 152, 879 (1963).

471. Ogibin, Yu. N., and Nikishin, G. I. Radical Addition of Methyl Acetoxyacetate to Olefins. Angew. Chem. 76, 713 (1964).

472. Oswald, Alexis A., Griesbaum, Karl, Hudson, Boyd E., Jr., and Bregman, Jack M. Organic Sulfur Compounds. XIII. Free-Radical Addition of Thiols to Phenylacetylene. J. Am. Chem. Soc. 86, 2877 (1964).

473. Overberger, C. G., Tobkes, Martin, and Zweig, Arnold. Azo Compounds. XLI. Decomposition of 2,2'-Axobis(2-cyclopropylpropionitrile). A Possible Rearrangement of a Cyclopropylcarbinyl Free Radical. J. Org. Chem. 28, 620 (1963).

474. Paris, Jean P., Gorsuch, John D., and Hercules, David M. Titration of Oxygen and Antioxidants Using 2, 4-Tri-tert-butylphenoxy Free Radicals. *Anal. Chem.* 36, 1332 (1964).

475. Parlant, C. The Liquid Phase Oxidation of Secondary Alcohols by Oxygen. *Rev. Inst. Franc. Petrole Ann. Combust. Liquides* 19, 1 (1964).

476. Partlett, Paul D., and Montgomery, Lawrence K. Kinetics and Reactivity in the Addition of 1,1-Dichloro-2,2-difluoroethylene to Dienes. The Biradical Mechanism. *J. Am. Chem. Soc.* 86, 628 (1964).

477. Peiffer, Gilbert. Comparative Study of Ionic and Radical Reactivities of Ethylenic and Acetylenic Bonds and of the Allenic Chain. *Compt. Rend.* 257, 3605 (1963).

478. Petrov, A. D., Nikishin, G. I., Vorob'ev, V. D., and Ogibin, Yu. N. Free Radical Addition of Acids and Alcohols to  $\alpha$ -Olefins. *Vortraege Originalfassung Intern. Kongr. Grenzflaechenaktive Stoffe*, 3., Cologne 1, 78 (1960).

479. Ponomarev, A. N., and Tal'roze, V. L. Theory of Addition of Atomic Hydrogen in the Gas Phase to Solid Olefins at Low Temperature. *Kinetika i Kataliz* 4, 657 (1963).

480. Poutsma, M. L., and Hinman, R. L. Calorination Studies of Unsaturated Materials in Nonpolar Media. I. Solvent Effects on Radical Addition of Chlorine to Chloroethylenes. *J. Am. Chem. Soc.* 86, 3807 (1964).

481. Purnell, J. H., and Quinn, C. P. The Pyrolysis of Butane. *Proc. Royal Soc. (London) Ser. A* 270, 267 (1962).

482. Razuvayev, G. A., and Domrachev, G. A. Reactions of Bis-arene Chromium With Alkyl Halides. *Tetrahedron* 19, 341 (1963).

483. Razuvayev, G. A., and Zateev, B. G. The Possibility of Isomerization of the Phenyl Radical in Reactions of Benzoyl Peroxide. *Dokl. Akad. Nauk SSSR* 148, 863 (1963).

484. Razuvayev, G. A., Zateev, B. G., and Myakov, V. N. The Possibility of Isomerization of the Phenyl Radical in Free Radical Reactions of Diphenylmercury. *Ibid.* 154, 164 (1964).

485. Reinheckel, Heinz. Radical Course of the Reaction Triethylaluminum and Carbon Tetrachloride. *Tetrahedron Letters*, 1939 (1964).

486. Reusch, William, and Johnson, Calvin Keith. Radical and Thermal Rearrangement of Isophorone Oxide. *J. Am. Chem. Soc.* 84, 1759 (1962).

487. Reutov, O. A., Ostapchuk, G. M., and Remova, V. A. Isomerization of Free Dideuteriopropyl Radical in Solution. *Izv. Akad Nauk SSSR, Ser. Khim.*, 519 (1964).

488. Riccoboni, Luigi, Belluco, Umberto, and Tagliavini, Giuseppe. Organometallics. VI. Reaction Between Tetramethyllead and Gold Trichloride. *Ricerca Sci. Rend. Ser. A2*, 323 (1962).

489. Rodgers, Alan S. Kinetics of Fluorination. I. Addition of Fluofine to 2,3-Dichlorohexafluoro-2-butene. *J. Phys. Chem.* 67, 2799 (1963).

490. Ruechardt, Christoph, and Hecht, Roland. Radical Rearrangement. VI. Neighboring Group Participation in Perester Decomposition. *Tetrahedron Letters*, 957 (1962).

491. Ruechardt, Christoph, and Hecht, Roland. Radical Rearrangement. VII. Rate of Migration of the Substituted Phenyl Group in Thermal Decomposition of Tert-Butyl Esters of Neophylpercarboxylic Acids. *Ibid.*, 961 (1962).

492. Ruechardt, Christoph, and Trautwein, Helmut. Radical Rearrangement. V. Migration Ratios in the Kharasch Reaction of  $\beta$ -Aryl-isobutyl Chlorides. *Ber.* 96, 160 (1963).

493. Sabatino, Edward C., and Gritter, Roy J. The Free-Radical Chemistry of Cyclic Ethers. V.  $\beta$ -Hydrogen Atom Abstraction From Epoxides and a Thioepoxide. *J. Org. Chem.* 28, 3437 (1963).

494. Sagert, N. H., and Laidler, K. J. Kinetics and Mechanisms of the Pyrolysis of n-Butane. I. The Uninhibited Decomposition. *Can. J. Chem.* 41, 838 (1963).

495. Sagert, N. H., and Laidler, K. J. Kinetics and Mechanisms of the Pyrolysis of n-Butane. II. The Reaction Inhibited by Nitric Oxide. *Ibid.*, 848 (1963).

496. Sampson, R. J. The Reaction Between Ethane and Oxygen at 600-630°. *J. Chem. Soc.*, 5095 (1963).
497. Schmidt, C., and Sehon, A. H. The Thermal Decomposition of Peracetic Acid in the Vapor Phase. *Can. J. Chem.* 41, 1819 (1963).
498. Schoellkopf, U., Patsch, M., and Schaefer, H. Radical Mechanism of the Meisenheimer Rearrangement. *Tetrahedron Letters*, 2515 (1964).
499. Scott, George P., Soong, Chia Chu, Huang, Wann-Sheng, and Reynolds, Jon L. Telomerization by Free-Radical Mercaptan Chain Transfer. II. Telomers of Acrylate Esters With Simple Thiols. *J. Org. Chem.* 29, 83 (1964).
500. Seakins, M. Chloroform as an Accelerator of Propane Oxidation. *Proc. Roy. Soc. (London) Ser. A* 274, 413 (1963).
501. Sebera, D. K., and Taube, H. Organic Anions as Bridging Groups in Oxidation-Reduction Reactions. *J. Am. Chem. Soc.* 83, 1785 (1961).
502. Shine, H. J., Waters, J. A., and Hoffman, D. M. The Decomposition of Acetyl Peroxide in Solution. III. Kinetics and Use of Radical Traps. *Ibid.* 85, 3613 (1963).
503. Skell, Philip S., and Allen, Richard G. Cis-Trans Isomerization in Vinyl Radicals. Gas Phase Radical-Chain Addition of Hydrogen Bromide to Propyne. *Ibid.* 86, 1559 (1964).
504. Skell, Philip S., and Freeman, Peter K. The Free-Radical Addition of Deuterium Bromide to Cis- and Trans-1-deutero-1-hexene. *J. Org. Chem.* 29, 2524 (1964).
505. Skell, P. S., and Pavlis, R. R. Stereospecific Trans Photoaddition of Elementary Iodine to Aliphatic Olefins. Bridged Jodoalkyl Radicals. *J. Am. Chem. Soc.* 86, 2956 (1964).
506. Skell, P. S. and Read, P. D. Stereochemical Evidence for Bridged Radicals. Photobromination of 4-Cis- and 4-Trans-bromo-tert-butylcyclohexane. *Ibid.*, 3334 (1964).

507. Skell, P. S., Tuleen, D. L., and Read, P. D. Stereochemical Evidence of Bridged Radicals. *Ibid.* 85, 2849 (1963).

508. Skell, P. S., Tuleen, D. L., and Read, P. D. The Mechanism of Aliphatic Bromination by N-bromosuccinimide. *Ibid.*, 2850 (1963).

509. Skinner, W. A. Vitamin E Oxidation With Free Radical Initiators. Azobis(isobutyronitrile). *Biochem. Biophys. Res. Commun.* 15, 469 (1964).

510. Soundararajan, S. Electric Dipole Moments and Molecular Structure of Aliphatic Nitro Compounds and Oximes. *Tetrahedron* 19, 2171 (1963).

511. Spona, J. The Role of Free Radicals in Oxidative Phenol Coupling. *Oesterr. Chemiker-Zig.* 65, 47 (1964).

512. Stadnik, P. M., and Gomonai, V. I. Study, by Quenching, of the Heterogeneous-Homogeneous Mechanism for the Oxidation of Methane on a Quartz Surface. *Ukr. Khim. Zh.* 29, 1052 (1963).

513. Streitwieser, Andrew, Jr. Molecular Orbital Correlations in Organic Chemistry. US Dept. Com., Office Tech. Serv., AD 255, 313, 34 pp. 1961.

514. Suzuki, Kazuo, and Fujimoto, Minoru. Fluorene Derivatives. XXI. The Radical Bromination of 9, 9'-Bifluorene and Its Derivatives by N-bromosuccinimide. *Bull. Chem. Soc. Japan* 36, 1654 (1963).

515. Tedder, J. M., and Walton, J. C. Free Radical Addition to Olefins. I. Addition of Bromotrichloromethane to Ethylene. *Trans. Faraday Soc.* 60, 1769 (1964).

516. Titov, A. I. Free Radical Mechanism of Nitration. *Tetrahedron* 19, 557 (1963).

517. Tokumaru, Katsumi, Inamoto, Naoki, and Shimamura, Osamu. Decomposition of Peroxybenzoic Acid in Solution. IV. Decomposition in Solvents in the Presence of Radical-Generators. *Bull. Chem. Soc. Japan* 36, 72 (1963).

518. Tokumaru, Katsumi, and Shimamura, Osamu. Decomposition of Peroxybenzoic Acid in Solution. V. Decomposition of Peroxybenzoic Acid and of Benzoyl Peroxide in Binary Mixtures of Carbon Tetrachloride With Cyclohexane, Toluene, or Diethyl ether. *Ibid.*, 76 (1963).
519. Totter, John R., Stevenson, Wayne, and Philbrook, G. E. Chain Reactions in the Chemiluminescent Oxidation of Certain Phthalazine-diones by Potassium Peroxydisulfate. *J. Phys. Chem.* 68, 752 (1964).
520. Trecker, David J., and Henry, Joseph P. Free-Radical Additions to Norbornadiene. *J. Am. Chem. Soc.* 85, 3204 (1963).
521. Trimm, D. L., and Cullis, C. F. Radical Isomerization During the Gaseous Oxidation of 2,3-Dimethylbutane. *J. Chem. Soc.*, 1430 (1963).
522. Urry, W. H., and Bilow, Norman. Free-Radical Reactions of Diazomethane With Reactive Bromopolychloroalkanes. *J. Am. Chem. Soc.* 86, 1815 (1964).
523. Urry, W. H., Trecker, D. J., and Hartzler, H. D. Free-Radical Rearrangements. II. Ketones and Esters From the Reactions of Aldehydes With Peroxides. *J. Org. Chem.* 29, 1663 (1964).
524. Vasil'eva, E. I., Keda, B. I., and Freidlina, R. Kh. The Reaction of Cyanogen Chloride With Vinyl Ethyl Ether in the Presence of Radical Process Initiators. *Dokl. Akad. Nauk SSSR* 154, 129 (1964).
525. Wallace, T. J., and Gritter, R. J. Free Radical Chemistry of Cyclic Ethers. IV. Free Radical Rearrangement of Epoxides. *Tetrahedron* 19, 657 (1963).
526. Wallace, Thomas J., Gritter, Roy J., and Walsh, Harold G. Free Radical Chemistry of Cyclic Esters: p-Dioxane and Morpholine. *Nature* 198, 284 (1963).
527. Walling, Cheves, and Pearson, Myrna Schmidt. Some Radical Reactions of Trivalent Phosphorus Derivatives With Mercaptans, Peroxides, and Olefins. A New Radical Cyclization. *J. Am. Chem. Soc.* 86, 2262 (1964).

528. Walling, Cheves, and Wagner, Peter. Effects of Solvent on Transition States in the Reactions of Tert-Butoxy Radicals. *Ibid.* 85, 2333 (1964).

529. Wasmuth, G. R., Edwards, Charles, and Hutcherson, Richard. Participation of the  $\text{SO}_2^-$  Radical Ion in the Reduction of p-Nitrophenol by Sodium Dithionite. *J. Phys. Chem.* 68, 423 (1964).

530. Yoshida, Zenichi, Matsumoto, Toshihiko, and Oda, Ryōhei. Free Radical Reactions. VII. Influence of Amounts of Reaction Components on Direct Ring Amination of Benzote Acid. *Kogyo Kagaku Zasshi* 67, 64 (1964).

#### METAL IONS AND FREE RADICALS.

531. Arnett, Edward M., and Mendelsohn, Morris A. Destructive Autoxidation of Metal Chelates. III. Effects of Additives on the Reaction. Metal Acetylacetones as Radical Sources. *J. Am. Chem. Soc.* 84, 3821 (1962).

532. Arnett, Edward M., and Mendelsohn, Morris A. Destructive Autoxidation of Metal Chelates, IV. Kinetics and Mechanism. *Ibid.* 3824 (1962).

533. Beckwith, A. L. J., and Evans, G. W. Mechanism of the Reactions of Peresters Catalyzed by Copper Salts. *Proc. Chem. Soc.* 63 (1962).

534. Beckwith, A. L. J., and Low, Beng See. Thiol Radicals. IV. Reactions, Catalyzed by Ferrous Ion, of Polycyclic Aromatic Hydrocarbons With Tert-Butyl Hydroperoxide and Mercapto Compounds. *J. Chem. Soc.* 2571 (1964).

535. Clark, R. J. H., and Williams, C. S. Far-Infrared Study of Metal-Pyridine Complexes. *Chem. Ind. (London)* 1317 (1964).

536. Closs, G. L., and Closs, L. E. Negative Ions of Porphin-Metal Complexes. *J. Am. Chem. Soc.* 85, 818 (1963).

537. Collinson, E., Dainton, F. S., Mile, B., Tazuke, S., and Smith, D. R. Thermal Redox Reactions Between Metal Ions and Radicals in Aqueous Solutions. *Nature* 198, 26 (1963).

538. Eaton, D. R. Complexing of Metal Ions With Semi-quinones. An Electron Spin Resonance (E.S.R.) Study. Inorg. Chem. 3, 1268 (1964).

539. Ehrenberg, Anders, and Hennerich, Peter. The Near Infrared Absorption of Metal Complexes With Flavine Free Radicals. Acta Chem. Scand. 18, 1320 (1964).

540. Evans, Alwyn G., and Tabner, B. J. The Catalytic Action of Anionic Catalysts. IV. The Importance of the Positive Counterion. J. Chem. Soc., 4613 (1963).

541. Goto, Royzo, Maruyama, Kazuhiko, Tanikaga, Rikuhei, and Deguchi, Yasuo. Metal Ketyles of Benzophenone Derivatives. I. Bull. Chem. Soc. Japan 35, 1746 (1962).

542. Gould, Edwin S., and Taube, Henry. Electron Transfer Through Organic Structural Units. Aromatic and Heterocyclic Carboxylates as Bridging Groups in Oxidation-Reduction Reactions. J. Am. Chem. Soc. 86, 1318 (1964).

543. Gould, Edwin S., and Taube, Henry. Isomeric Pyridine-carboxylates as Bridging Groups in Oxidation-Reduction Reactions. Electron Transfer Through Nitrogen. Ibid. 85, 3706 (1963).

544. Gritter, Roy J., and Patmore, Edwin L. The Free-Radical Reactions of Coordinated Compounds. 2,4-Pentanedion Chelates. Proc. Chem. Soc., 328 (1962).

545. Herzog, S., Geisler, K., and Praekel, H. A Neutral Complex of Aluminum With 2,2'-Bipyridine. Angew. Chem. 75, 94 (1963).

546. Hubo, H., Shiga, T., Uozumi, M., and Isomato, A. Electron Spin Resonance (E.S.R.) of Flavine Enzymes. Bull. Soc. Chim. Biol. 45, 219 (1963).

547. Ingram, D. J. E. The Method and Technique of Electron Resonance and Its Application to Metal Complexes. Spectry. Repl. Conf. Organ. Hydrocarbon Res. Group Inst. Petrol., London, 85 (1962).

548. Jezowska-Trzebiatowska, B. The Role of Oxygen in Complex Compounds. J. Chim. Phys. 61, 765 (1964).

549. Kemp, T. J., and Waters, William A. Oxidation of Malonic Acid by Manganic Sulfate. *J. Chem. Soc.*, 1489 (1964).

550. Kitagawa, Toyokichi, Layloff, Thomas P., and Adams, Ralph N. Effect of Metal Ions on Nuclear Hyperfine Coupling Constants in Electron Paramagnetic Resonance Spectra. *Anal. Chem.* 36, 925 (1964).

551. Kochi, Jay K. Reactions of Peroxides Catalyzed by Metal Salts. VI. The Decomposition of Peroxides Catalyzed by Copper Compounds and the Oxidation of Alkyl Radicals by Cupric Salts. *J. Am. Chem. Soc.* 85, 1958 (1963).

552. Kochi, Jay K., and Davis, Dennis D. Electron Transfer in Free Radical Chain Transfer Reactions. *Nature* 202, 690 (1964).

553. Kochi, Jay K., and Mog, David M. Oxidation of  $\alpha$ -Cyanoalkyl Radicals by Cupric Salts. *Chim. Ind. (Milan)* 46, 676 (1964).

554. Kochi, Jay K., and Rust, Frederick F. Oxidation of Free Radicals From Unsaturated Compounds by Cupric Salts. *J. Am. Chem. Soc.* 84, 3946 (1962).

555. Kriens, Richard Duane. Effects of Metal Ions in Free Radical Reactions. *Dissertation Abstr.* 24, 3985 (1964).

556. Kubo, Hideo, Watari, Hiroshi, Suga, Takeshi, Isomoto, Akio, Uozumi, Mitsuro, and Kado'a, Ken. Electron Spin Resonance (E.S.R.) of Flavine and Flavine Enzyme Semiquinones. *Koso Kagaku Shimpōjiumu* 17, 24 (1962).

557. Lawesson, Sven Olov, and Sosnovsky, George. Syntheses With Peresters Catalyzed by Metal Ions. *Svensk. Kem. Tidskr.* 75, No. II, 568 (1963).

558. Leussing, D. L., and Tischer, T. N. Iron-Catalyzed Autoxidation of Mercaptoacetate. Facilitation of a Two-Electron Transfer Through Coordination. *Advan. Chem. Ser.* 37, 216 (1963).

559. Longuet-Higgins, H. C., and Stone, A. J. The Electronic Structure and Electronic Spin Resonance of Tricyclopentadienyl Trinickel<sup>1</sup> Dicarbonyl. *Mol. Phys.* 5, 417 (1962).

560. MacCragh, A., and Koski, W. S. Electron Paramagnetic Resonance (E.P.R.) Spectrum of Silver Phthalocyanine. *J. Am. Chem. Soc.* 85, 2375 (1963).

561. Maruyama, Kazuhiro. Metal Ketyl of Phenanthraquinone and Its Derivatives. *Bull. Chem. Soc. Japan* 37, 553 (1964).

562. Maruyama, Kazuhiro, Tanikaga, Rikuhei, and Goto, Ryozo. Metal Ketyl of Benzophenone Derivatives II. Electron Spin Resonance (E.S.R.) Spectra of Ketyl of Ortho-Substituted Benzophenones. *Nippon Kagaku Zasshi* 84, 75 (1963).

563. Minisci, Francesco, Cecere, Mirella, and Galli, Remo. Oxidation of Carbon Free Radicals in the Presence of Cu and Fe Salts. New Synthesis of Nitro Derivatives and Nitric Esters. *Gazz. Chim. Ital.* 93, 1288 (1963).

564. Mori, Masayasy, and Fujiwara, Shizuo. Preparation of Strictly Halide Complexes of Cu(II) and Their Electron Paramagnetic Resonance (E.P.R.) Spectra. *Bull. Chem. Soc. Japan* 36, 1636 (1963).

565. Mueller, Eugen, Ziemeck, Peter, and Rieker, Anton. Reactions of Free Radicals With Metalloorganic Compounds. II. The Radical System 2,4,6-Tri-tert-butylphenoxytriphenylaluminum. *Tetrahedron Letters*, 207 (1964).

566. Nishiguchi, Hiroaki, Nakai, Yasuto, Nakamura, Kasuo, Kazuhiko, Ishizu, Deguchi, Yasuo, and Takaki, Hideo. Alkali Metal Hyperfine Structure in the Electron Spin Resonance Spectra of Biphenyl Mononegative Ions. *J. Chem. Phys.* 40, 241 (1964).

567. Ochiai, E. Mechanism of Catalysis by Metal Complexes in Autoxidation of an Olefin. *Tetrahedron* 20, 1819 (1964).

568. Ochiai, E. Mechanism of Oxidative Coupling Reaction Catalyzed by Cuprous Chloride-Amine Complex. *Ibid.*, 1831 (1964).

569. Owen, S. J. T., Standley, K. J., and Walker, A. Electron Spin Resonance (E.S.R.) in Anhydrous Copper Nitrate. *J. Chem. Phys.* 40, 183 (1964).

570. Perevalova, E. G., Ustyynyuk, Yu. A., and Nesmeyanov, A. N. Reactivity of Compounds Containing the Ferrocenylmethyl Group. I. Hydrolytic Cleavage of the Quaternary Ammonium Salts. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 1036 (1963).

571. Perevalova, E. G., Ustyynyuk, Yu. A., and Nesmeyanov, A. N. Reactivity of Compounds Containing the Ferrocenylmethyl Group. II. Emde Reduction by Na Amalgam of Quaternary Ammonium Salts Containing the Ferrocenylmethyl Radical. *Ibid.*, 1045 (1963).

572. Piskunov, A. K., Shigorin, D. N., and Stepanov, B. I. Investigation of Electron Paramagnetic Resonance (E.P.R.) in Intercomplexes of Copper. *Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go Soveshch.*, Leningrad 2, 119 (1960).

573. Rajan, R. Electron Spin Resonance (E.S.R.) in Copper(II) Monoethylenediamine Chloride. *Physica* 29, 1191 (1963).

574. Rajan, R. Electron Spin Resonance (E.S.R.) in Cupric Acid Fluoride. *Ibid.* 28, 1329 (1962).

575. Rajan, R. Electron Spin Resonance (E.S.R.) in Monomethylammonium Copper(II) Chloride. *Indian J. Pure Appl. Phys.* 1, No. 3, 121 (1963).

576. Rajan, R., and Reddy, T. Ramasubba. Electron Spin Resonance in Ethylenediamine Complexes of Copper(II) Sulfate. *J. Chem. Phys.* 39, 1140 (1963).

577. Ranon, U., and Low, W. Electron Spin Resonance of  $\text{Er}^{3+}$  in  $\text{CaF}_2$ . *Phys. Rev.* 132, 1609 (1963).

578. Raoult, G., Declaux, A. M., and Chenon, M. T. Electron Paramagnetic Resonance of Nickel Ion in a Single Crystal of Alumina. *Proc. Colloq. AMPERE* 11, 456 (1962).

579. Razuvayev, G. A. Free Radicals in Reactions of Organometallic Compounds. *Zh. Vses. Khim. Obshchestva im. D. I. Mendeleva* 7, 325 (1962).

580. Razuvayev, G. A., and Boguslavskaya, L. S. Reaction Capacity of Free Hydroxyl Radicals With Aliphatic Esters in Solution. *Bul. Inst. Politeh. Iasi* 8, 141 (1962).

581. Rein, H., Ristau, O., and Jung, F. Electron Spin Resonance (E.S.R.) Investigations on a Homologous Series of Copper(II) Complexes. *Z. Physik. Chem.* 221, 197 (1962).

582. Rooney, J. J., and Hathaway, B. J. The Nature of the Blue Species Formed by the Interaction of 1, 1-Diphenylethylene With Silica-Alumina. *J. Catalysis* 3, 447 (1964).

583. Sancier, K. M., and Mills, J. S. The Electron Spin Resonance (E.S.R.) of Chromium(III) Complexes in Aqueous Solution. *J. Phys. Chem.* 67, 1438 (1963).

584. Schneider, J., Holton, W. C., Estle, T. L., and Raeuber, A. Electron Spin Resonance in Self-Activated ZnS Crystals. *Phys. Letters* 5, 312 (1963).

585. Schneider, J., Sircar, S. R., and Raeuber, A. Electron Spin Resonance (E.S.R.) of Mn<sup>2+</sup> Ions in Cubic and Hexagonal Crystal Fields of ZnS. *Z. Naturforsch.* 18a, 980 (1963).

586. Spackman, J. W. C. Electron Spin Resonance (E.S.R.) of Molybdenum Disulfide. E.S.R. of Charge Carriers in Impure Molybdenum Disulfide. *Nature* 198, 1266 (1963).

587. Spacu, P., Voicu, V., and Pascaaru, I. Paramagnetic Resonance of Some Copper(II) Complexes. *J. Chim. Phys.* 60, 368 (1963).

588. Stanton, Jimmy Howard. The Interaction of Three Metal Ions With the Surface of Silica Gel. *Dissertation Abstr.* 25, 138 (1964).

589. Stepanov, B. I., and Korolev, B. A. Study of the Copper Complexes of Some Azocompounds by the Techniques of Electron Paramagnetic Resonance (E.P.R.) and Polarography. *Tr. Vses. Mezhdunarodn. Tekhn. Konf. po Vopr. Sinteza i Primeneniya Organ. Krasitelei*, 57 (1961).

590. Stolarczyk, L. Hydroxyl Radical-Initiated Chain Oxidation of Iron(II) in Air-Saturated Acid Solutions Containing Alcohols. II. Reffined Analysis of G (Fe<sup>3+</sup>) in the Presence of C<sub>2</sub>H<sub>5</sub>OH After Pulse Electron Irradiation. *Nukleonika* 8, 313 (1963).

591. Stolarczyk, L. Hydroxyl Radical-Initiated Chain Oxidation of Iron(II) in Air-Saturated Acid Solutions Comtaining Alcohols. III. Chain Processes in  $\gamma$ -Irradiated Solutions Containing C<sub>2</sub>H<sub>5</sub>OH. *Ibid.*, 391 (1963).

592. Tate, S. S., Grzybowski, A. K., and Datta, S. P.  
Stability Constants of the Magnesium Complexes of the Keto and Enol Isomers  
of Oxaloacetic Acid at 25°. J. Chem. Soc., 1381 (1964).

593. Terent'ev, A. P., Panova, G. V., Shigorin, D. N., and  
Rukhadze, E. G. Electron Paramagnetic Resonance (E.P.R.) Spectra of  
Optically Active Chelated Compounds of Copper With Hydroxy Aldimines  
and Hydroxy Ketimines. Dokl. Akad. Nauk SSSR 156, 1174 (1964).

594. Tikhomirova, N. N., Zamaraev, K. I., and Berdnikov,  
V. M. Study of Copper-Ammonia Solutions by the Electron Paramagnetic  
Resonance (E.P.R.) Method. Zh. Strukt. Khim. 4, 449 (1963).

595. Title, Reuben S. Cubic Field Splitting of the Eu<sup>++</sup> Electron  
Paramagnetic Resonance (E.P.R.) Spectrum in the Alkaline Earth Fluorides.  
Phys. Letters 6, 13 (1963).

596. Title, Reuben S. Electron Paramagnetic Resonance  
Spectra of Cr<sup>+</sup>, Mn<sup>++</sup>, and Fe<sup>+++</sup> in Cubic ZnS. Phys. Rev. 131, 623 (1963).

597. Toyoda, Koichi, and Ochiai, Kazuo. Electron Spin  
Resonance Spectra of Some Copper(II) Complexes. Proc. Intern. Symp.  
Mol. Struct. Spectry., Tokyo, 4 pp. (1962).

598. Vinokurov, V. M., Zaripov, M. M., Rol'skii, Yu. E.,  
Stepanov, V. G., Chirkin, G. K., and Shekun, L. Ya. Electron Paramag-  
netic Resonance (E.P.R.) of Gd<sup>3+</sup> in CaF<sub>2</sub>. Fiz. Tverd. Tela 5, 2902  
(1963).

599. Vos, Kenneth Dean. Electron Paramagnetic Resonance  
Absorption Studies on Solutions of Metals in Ammonia and Amines. Disser-  
tation Abstr. 24, 3119 (1964).

600. Vos, Kenneth D., and Dye, James L. Hyperfine Inter-  
actions in Solutions of Cs and Rb in Methylamine. J. Chem. Phys. 38,  
2033 (1963).

601. Waldner, F. Electron Paramagnetic Resonance (E.P.R.)  
Spectrum of Mn<sup>++</sup> in Natural MgAl<sub>2</sub>O<sub>4</sub> Spinel. Helv. Phys. Acta 35, 756  
(1962).

602. Wei, Peter Entien, Corwin, Alsoph H., and Arellano,  
Roberto. Porphyrins. XXII. Preparation of Chelates of Porphyrins and  
Phthalocyanine With "Magnesium Viologen." J. Org. Chem. 27, 3344  
(1962).

603. Wiersma, A. K.; and Windle, J. J. Electron Paramagnetic Resonance (E.P.R.) of Some Nitrogen Bonded Copper Chelates. *J. Phys. Chem.*, 68, 2316 (1964).

604. Wojciechowski, W., and Jezowska-Trzebiawska, B. Electron Spin Resonance (E.S.R.) in Binuclear Chromium(III) Complexes. *Bull. Acad. Polon. Sci., Ser. Sci. Chim.*, 11, 79 (1963).

605. Wolf, Hans Christoph, and Hauser, Karl H. Electron Spin Resonance of F Centers in Rubidium Halide Crystals. *Naturwissenschaften* 46, 646 (1959).

606. Yafaev, N. R., Garif'yanov, N. S., and Yablokov, Yu. V. Electron Paramagnetic Resonance (E.P.R.) of  $W^{5+}$  in Glasses. *Fiz. Tverd. Tela* 5, 1673 (1963).

#### ELECTRON SPIN RESONANCE.

607. Abakumov, G. A., Shilov, A. E., and Shulyndin, S. V. Electron Paramagnetic Resonance of Products of the Interaction of Dicyclopentadienylvanadium Dichloride With Aluminum Alkyls. *Kinetika i Kataliz* 5, 228 (1964).

608. Abkowitz, M., and Honig, A. Electron Paramagnetic Resonance (E.P.R.) Apparatus Operating at Liquid  $He^3$  Temperatures. *Rev. Sci. Instr.* 33, 568 (1962).

609. Adams, J. Q., and Thomas, J. R. Electron Paramagnetic Resonance (E.P.R.) of a Hydrazine Radical Ion. *J. Chem. Phys.* 39, 1904 (1963).

610. Akasaka, Kazuyuki, Ohnishi, Shunichi, Saita, Tokuo, and Nitta, Isamu. Electron Spin Resonance (E.P.R.) of a Single Crystal of L-Cystine Dihydrochloride Irradiated at Low Temperature. *J. Chem. Phys.* 40, 3110 (1964).

611. Allen, B. T., and Bond, A. The Hyperfine Structure of the Electron Spin Resonance (E.S.R.) Spectrum of Semiquinone Phosphates. *J. Phys. Chem.* 68, 2439 (1964).

612. Allen, Harry C., Jr., Kokoszka, Gerald F., and Inskeep, Richard G. Electron Paramagnetic Resonance (E.P.R.) Spectrum of Some Tris Complexes of  $Cu^{II}$ . *J. Am. Chem. Soc.* 86, 1023 (1964).

613. Anderson, A. F. H., and Calvin, Melvin. Electron Spin Resonance (E.S.R.) of Crystalline Chlorophyll and Crude Mixtures of Chlorophyll a With Normally Associated Pigments. Nature 199, 241 (1963).

614. Anderson, D. H., Gutowsky, H. S., and Sandin, R. B. Electron Spin Resonance (E.S.R.) Studies of a Weakly Coupled Biradical. US Dept. Com., Office Tech. Serv., AD 158,021, 26 pp. 1960.

615. Aono, Shigeyuki, and Ohaani, Kunio. Electron Spin Resonance of the Aromatic Alkali Metal System. Progr. Theoret. Phys. 30, 162 (1963).

616. Arat, S., Shida, S., Yamaguchi, K., and Kuri, Z. E.S.R. (Electron Spin Resonance) Spectrum of Electron-Irradiated Cycloheptatriene. Cycloheptatrienyl Radical. J. Chem. Phys. 37, 1885 (1962).

617. Arbuzov, A. E., Valitova, F. G., Il'yasov, A. V., Kozyrev, B. M., and Yablokov, Yu. V. A Study of a, o-Diphenyl-B-(pentaphenylcyclopentadienyl)hydrazyl Free Radical by Electronic Paramagnetic Resonance Method. Dokl. Akad. Nauk SSSR 147, 99 (1962).

618. Arbuzov, B. A., Butenko, G. G., and Yablokov, Yu. N. A Study of Some Polyene Ketones by Electronic Paramagnetic Resonance (E.P.R.). Izv. Akad. Nauk SSSR. Ser. Khim., 1511 (1963).

619. Atherton, N. M., and Harding, R. S. F. Temperature-Dependent Hyperfine Splitting in a Sterically Hindered Radical. Nature 198, 987 (1963).

620. Avramenko, L. I., Buben, N. Ya., Kolesnikova, K. V., Tolkachev, V. A., and Chkheidze, I. I. Examination by Means of Electron Paramagnetic Resonance (E.P.R.) of the Radicals Formed in the Reaction of Hydrogen Atoms With Benzene. Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, 2079 (1962).

621. Ayscough, P. B., and Wilson, R. Electron Spin Resonance (E.S.R.) Studies of Radical Anions. I. Aromatic Ketols. J. Chem. Soc., 5412 (1963).

622. Ayscough, P. B., Sargent, F. P., and Wilson, R. Electron Spin Resonance (E.S.R.) Studies of Radical Anions. II. Aromatic Nitro Compounds. Ibid., 5418 (1963).

623. Bar-Eli, Kedma, and Tuttle, T. R., Jr. Electron Spin Resonance of Amine Solutions of Alkali Metals. *J. Chem. Phys.* 40, 2508 (1964).

624. Bartelink, H. J. M., Bos, H., Smidt, J., Vrinsen, C. H., and Adema, E. H. Electron Spin Resonance Studies on Ziegler Catalyst Systems. III. Some Mixtures of Aluminum Methyl Compounds and Aluminum Chloride With Bis-Cyclopentadienyl Titanium Dichloride and Bis-Cyclopentadienyl Methyl Chlorotitanium. *Rec. Trav. Chim.* 81, 225 (1962).

625. Barton, B. L., and Fraenkel, George K. Electron-Spin Resonance (E.S.R.) Spectra of Methyl-Substituted Dihydropyrazine Cations and Related Radicals. *J. Chem. Phys.* 41, 1455 (1964).

626. Barton, B. L., and Fraenkel, George K. Signs of the Isotropic Hyperfine Splittings in the Electron Spin Resonance Spectrum of the Dihydropyrazine Cation Radical. *Ibid.*, 695 (1964).

627. Basaev, R. M., Machtina, K. A., Chernyakovskii, F. P., and Musabekov, Yu. S. Electron Paramagnetic Resonance (E.P.R.) of Alizarin Dyes. *Uch. Zap. Yaroslavsk. Tekhnol. Inst.* 1, 259 (1962).

628. Beasley, Edward Evans. Electron Spin Resonance in Photolyzed Hydrocarbon Glasses Containing Peroxides. *Dissertation Abstr.* 24, 5488 (1964).

629. Beasley, Edward E., and Anderson, Roy S. Electron Spin Resonance (E.S.R.) of Ultraviolet-Irradiated Compounds. II. Peroxide-Initiated Radicals in Straight-Chain Alkenes. *J. Chem. Phys.* 40, 2565 (1964).

630. Bedford, J. A., Bolton, J. R., Carrington, A., and Prince, R. H. Electron Spin Resonance Spectra of the Phenyltrimethylsilane and -Germane Anions:  $\pi$  Bonding Between Silicon and Germanium and the Aromatic Ring. *Trans. Faraday Soc.* 59, 53 (1963).

631. Belonogov, A. M., Sazonov, A. M., Serdyuk, A. S., Marchenko, V. N., and Rusakov, A. F. Spectrometer for Observation of Electron Paramagnetic Resonance (E.P.R.) in Solid Bodies. *Geofiz. Priborostroj. Sb.*, 94 (1963).

632. Bennett, J. E. Electron Spin Resonance (E.S.R.) Spectra of  $\gamma$ -Irradiated Alkoxides. *Nature* 203, 514 (1964).

633. Bernal, Ivan. Electron Spin Resonance Spectra of Electrolytically Generated Anion Radicals. *Dissertation Abstr.* 24, 4420 (1964).

634. Bernheim, R. A., Kempf, R. J., Humer, P. W., and Skell, P. S. Electron Paramagnetic Resonance (E.P.R.) of Triplet Cyanomethylene. *J. Chem. Phys.* 41, 1156 (1964).

635. Bershov, L. V., and Marfunin, A. S. Chemical Bond Estimation From the Hyperfine Structure of Mn Electron Spin Resonance Spectra. *Dokl. Akad. Nauk SSR* 155, 632 (1964).

636. Bersohn, Malcolm, and Thomas, J. R. Identification of Peroxy Radicals by Electron Paramagnetic Resonance. *J. Am. Chem. Soc.* 86, 959 (1964).

637. Bersuker, I. B. Spin-Inversion Levels in Magnetic Fields and the Electron Paramagnetic Resonance (E.P.R.) Spectrum of Octahedral Cu<sup>2+</sup> Ion Complexes. *Zh. Ekspерим. i Teor. Fiz.* 44, 1239 (1963).

638. Bersuker, I. B., and Vekhter, B. G. Electron Paramagnetic Resonance (E.P.R.) and Microwave Spectra of Transition Metal Octahedral Complexes of d<sup>1</sup> Configurations and an Account of Inversion Splitting. *Fiz. Tverd. Tela* 5, 2432 (1963).

639. Bersuker, I. B., Budnikov, S. S., Vekhter, B. G., and Chinik, B. I. Hyperfine Structure of the Electron Paramagnetic Resonance (E.P.R.) Spectra for Copper Complexes With Inversion Splitting. *Ibid.* 6, 2683 (1964).

640. Beseev, Cengiz, Lund, Anders, Vaangard, Tore, and Hakansson, Rolf. Proton and <sup>13</sup>C Splittings in the Electron Spin Resonance (E.S.R.) Spectra of Two Phenoxy Radicals. *Acta Chem. Scand.* 17, 2281 (1963).

641. Bill'yukovich, A. L. Device for Examination of Crystals by an (Electron Paramagnetic Resonance) E.P.R. U.S.S.R. 156, 342, August 21, 1963.

642. Bir, G. L. Intensity of Allowed and Forbidden Transitions in Electron Paramagnetic Resonance (E.P.R.). *Fiz. Tverd. Tela* 5, 2235 (1963).

643. Blandamer, M. J., Gough, T. E., Gross, J. M., and Symons, M. C. R. Unstable Intermediates. XXI. Effect of Ion Pairing of the Electron Spin Resonance (E.S.R.) Spectrum of m-Dinitrobenzene Anion. *J. Chem. Soc.*, 536 (1964).

644. Bleekrode, R., Dieleman, J., and Vegter, H. J. Electron Spin Resonance (E.S.R.) on Manganese in GaAs. *Phys. Letters* 2, 355 (1962).

645. Blyumenfel'd, L. A., Kalmanson, A. E., and Moshkovskii, Yu. Sh. Electron Paramagnetic Resonance (E.P.R.) Spectra in Compounds With Conjugated Bonds. *Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go* 2, 96 (1960).

646. Bodu, A., and Ciara, P. Determination of the Concentration of Unpaired Electrons by an Absolute Method Using an Electron Spin Resonance (E.S.R.) Spectrometer. *Acad. Rep. Populare Romine* 15, 385 (1964).

647. Bolte, Sara Jo Kleinheksel. A Study of Free Radicals in Irradiated Amides by Electron Spin Resonance Spectroscopy. *Dissertation Abstr.* 25, 118 (1964).

648. Bolton, James R., and Fraenkel, George K. Assignment of Hyperfine Splittings in Electron Spin Resonance Spectra by Line-Width Analyses. *J. Chem. Phys.* 41, 944 (1964).

649. Bolton, James R., and Fraenkel, George K. Electron Spin Resonance (E.S.R.) Study of the Pairing Theorem for Alternant Hydrocarbons:  $^{13}\text{C}$  Splittings in the Anthracene Positive and Negative Ions. *Ibid.* 40, 3307 (1964).

650. Bolton, J. R. Reinterpretation of the Electron Spin Resonance (E.S.R.) Spectrum of the o-Xylene Negative Ion. *Ibid.* 41, 2455 (1964).

651. Bolton, J. R., Carrington, A., and dos Santos-Veiga, J. Analysis of High-Resolution Electron Spin Resonance Spectra. A Reinterpretation of the Wurster's Blue Ion Spectra. *Mol. Phys.* 5, 615 (1962).

652. Bolton, J. R., Carrington, A., and dos Santos-Veiga, J. Electron Spin Resonance (E.S.R.) Studies of Semiquinones and Related Nitrogen Heterocyclic Molecules in Acid Solution. *Ibid.*, 465 (1962).

653. Bouldin, Walter Virgil. Electron Spin Resonance Studies of Free Radicals Produced by Irradiation at 4.2°K. Dissertation Abstr. 24, 351 (1963).
654. Bowers, V. A., Cochran, E. L., Foner, S. N., and Jen, C. I. Electron Spin Resonance (E.S.R.) of Alkali Atoms in Inert-Gas Matrixes. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 26-1-26-17 (1961).
655. Brandon, Roy W., Closs, Gerhard L., and Hutchison, Clyde A., Jr. Paramagnetic Resonance (E.P.R.) in Oriented Ground-State Triplet Molecules. J. Chem. Phys. 37, 1878 (1962).
656. Brandon, P. W., Gerkin, Roger E., and Hutchison, Clyde A., Jr. Electron Magnetic Resonance of Triplet States and the Detection of Energy Transfer in Crystals. Ibid., 447 (1962).
657. Brovetto, P., and Vighetto, E. Electron Spin Resonance Spectrum of the Triphenylmethyl Radical. Phys. Letters 5, 109 (1963).
658. Brown, Harmon W., and Jones, Robert C. Erratum: E.P.R. (Electron Spin Resonance) Spectrum of an Azulene Free-Radical Anion. J. Chem. Phys. 37, 1571 (1962).
659. Brown, Judith. Electron Spin Resonance (E.S.R.) in Solid and Liquid Salt Mixtures. J. Phys. Chem. 67, 2524 (1963).
660. Bruin, F., Heineken, F. W., and Bruin, M. Electron Spin Resonance Spectra of the Basic Indigo Dye Radicals. J. Org. Chem. 28, 562 (1963).
661. Bruin, M., Bruin, F., and Heineken, F. W. Electron Spin Resonance Spectra of the Negative Ions of Phenothiazine and Some of Its Derivatives. Ibid. 29, 507 (1964).
662. Brunner, Erwin, and Doerr, Friedrich. Electron Spin Resonance (E.S.R.) Spectra of Aromatic Radicals in Liquid Ammonia. Ber. Bunsenges. Physik. Chem. 68, 468 (1964).
663. Buchachenko, A. L. Electron Paramagnetic Resonance (E.P.R.) Spectra of Some New Radicals. Optika i Spektroskopiya 13, 795 (1962).

664. Buchachenko, A. L., Lebedov, Ya. S., and Neiman, M. B. A Study of Radical Antioxidants by Electron Paramagnetic Resonance (E.P.R.) Spectroscopy. I. Phenoxy Radicals. *Zh. Strukt. Khim.* 2, 558 (1961).

665. Bugai, A. A., and Ruban, M. A. A Spectrometer for the Study of Electron Paramagnetic Resonance (E.P.R.) in Solids at Low Temperatures. *Zavodsk. Lab.* 29, 1376 (1963).

666. Bugai, A. A., Deigen, M. O., Ruban, M. A., and Shatalov, A. A. Electron Paramagnetic Resonance (E.P.R.) of the Products of Photochemical and Thermal Combination of F-Centers in Alkali Halide Crystals. *Fiz. Probl. Spektroskopii, Akad. Nauk SSSR Materialy 13-go Z*, 116 (1960).

667. Bullock, A. T., and Sutcliffe, L. H. Electron Spin Resonance (E.S.R.) Spectra of Free Radicals Derived From Poly(methyl methacrylate). *Trans. Faraday Soc.* 60, 625 (1964).

668. Burns, Gerald. Concentration-Dependent Electron Spin Resonance (E.S.R.). *Phys. Rev.* 135, 479 (1964).

669. Butyagin, P. Yu., Kolbanev, I. V., and Radtsig, V. A. Electron Paramagnetic Resonance (E.P.R.) Spectra of Free Radicals in Products of Solid Polymer Destruction. *Fiz. Tverd. Tela* 5, 2257 (1963).

670. Campbell, D., Jackson, C., and Wynne-Jones, W. F. K. Electron Spin Resonance in Polymer Carbons: Halogens and Interhalogen Compounds. *Nature* 199, 1090 (1963).

671. Carlson, Frederick F. Paramagnetic Resonance (E.P.R.) of Nitrogen Atoms in X-Ray-Irradiated Sodium Azide. *J. Chem. Phys.* 39, 1206 (1963).

672. Carrington, A. Electron Spin Resonance Spectra of Aromatic Radicals and Radical-Ions. *Quart. Rev. (London)* 17, 67 (1963).

673. Carrington, A. Theory of Line Width Alternation in Certain Electron Resonance Spectra. *Mol. Phys.* 5, 425 (1962).

674. Carrington, A., and Longuet-Higgins, H. C. Line Width Variations in the Electron Resonance Spectra of Free Radicals in Solution. *Ibid.* 5, 447 (1962).

675. Carrington, A., and Smith, J. C. P. Electron Spin Resonance Spectrum of the Cycloheptatrienyl Radical in Aqueous Solution. *Mol. Phys.* 7, 99 (1963-1964).
676. Carrington, A., and Todd, P. F. Electron Spin Resonance Spectra of Alkyl Cyclooctatetraene Anions. *Ibid.*, 533 (1966-1964).
677. Carrington, A., and Todd, P. F. The Electron Spin Resonance (E.S.R.) Spectra of Some Aromatic Nitrile Anions. *Ibid.* 6, 161 (1963).
678. Carrington, A., Longuet-Higgins, H. C., and Todd, P. F. Negative Ions of Tetraphenylenne and 1,2;5,6-Dibenzocyclooctatetraene. *Ibid.* 6, 45 (1964).
679. Carrington, A., Todd, P., and dos Santos-Veiga, J. The Electron Spin Resonance Spectrum of the p-Dicyanotetrazine Anion. *Ibid.* 6, 101 (1963).
680. Carter, David L. Electron Paramagnetic Resonance and Maser Studies of  $\text{Fe}^{+++}$  in  $\text{TiO}_2$  (Rutile). *Dissertation Abstr.* 23, 2958 (1963).
681. Cerutti, Michele, Theobald, Jean Gerard, and Uebersfeld, Jean. Paramagnetic Resonance (E. S. R.) of a Pyrocarbon. *Compt. Rend.* 256, 3029 (1963).
682. Chambers, James Q., III, Layloff, Thomas, and Adams, Ralph N. Correlation of Solvent Effects on the Electron Paramagnetic Resonance (E.P.R.) Spectra of the Nitrobenzene Anion Radical. *J. Phys. Chem.* 68, 661 (1964).
683. Chapman, D., Glarum, S. H., and Massey, A. G. Electron Spin Resonance (E.S.R.) Studies of Phosphonitrilic and Borazole Ring Systems. *J. Chem. Soc.*, 3140 (1963).
684. Chatelain, A., and Buttet, J. Electronic Paramagnetic Resonance in Irradiated Rhombic Sulphur. *Helv. Phys. Acta* 37, 77 (1964).
685. Ch'iu, Tsu-Wen, Chu, Yu-Fen, T'ang, Hsueh-Ming, Hsiung, Fu-Chin, and Kung, Hsien-Yin. The Electron Spin Resonance (E.S.R.) Spectra of  $\pi-(\text{C}_5\text{H}_5)_2 \cdot \text{-TiCl}_2 \cdot \text{AlR}_3$  Soluble Catalyst System. *Wu Li Hsueh Pao* 17, 600 (1961).

686. Ch'iu, Tsu-Wen, Wang, Wen-Yun, and Chang, Shou-Hsin. The Electron Spin Resonance (E.S.R.) Spectra of Aromatic Ions. *Yao Hsueh Hsueh Pao* 19, 583 (1963).
687. Cho, Boong Youn. An Electron Spin Resonance Study of Some Organic Photoconductor Dyes. *Dissertation Abstr.* 23, 3442 (1963).
688. Chu, Chih-Ying, Fu, Kuei-Hsiang, Pan, Chia-Lai, Cheng, Huai-Yu, and Hu, Yu-Chieh. Paramagnetic Resonance of Aromatic Anions. I. Diphenylbenzene Isomer Anions. *K'o Hsueh T'ung Pao*, 160, (1964).
689. Cole, Terry, Kushida, Toshimoto, and Heller, Hanan C. Zero-Field Electron Magnetic Resonance in Some Inorganic and Organic Radicals. *J. Chem. Phys.* 38, 2915 (1963).
690. Colpa, J. P., and de Boer, E. Spin Polarization Versus Hyperconjugation in Electron Spin Resonance Spectra of Substituted Aromatic Systems. *Phys. Letters* 5, 225 (1963).
691. Cook, P., and Mallard, J. R. Electron Spin Resonance Cavity for the Detection of Free Radicals in the Presence of Water. *Nature* 198, 145 (1963).
692. Cook, R. J., and Whiffen, D. H. Electron Spin Resonance and Its Applications. *Phys. Med. Biol.* 7, 277 (1962).
693. Cornaz, P., and Borel, J. P. A Study of the Paramagnetic Resonance of Picrylaminocarbazyl as a Function of Temperature. *Helv. Phys. Acta* 34, 407 (1961).
694. Corvaja, C., and Giacometti, G. Electron Spin Resonance (E.S.R.) Spectra of Different Solvates of m-Nitrophenol Negative Ion in a Mixed Solvent. *J. Am. Chem. Soc.* 86, 2736 (1964).
695. Corvaja, C., Nordio, P. L., Pavan, M. V., and Rigatti, G. Electron Spin Resonance Spectra of Radical Ions of Carbonyl Compounds. III. Negative Ions of Dibenzoyl, Fluorenone, and Methyl Naphthyl Ketone. *Ric. Sci. Rend. Sez. A* 4, 297 (1964).
696. Crosignani, E., Franzosini, P., Siragusa, G., and Zanotti, L. Observations on the Paramagnetism of Phenothiazine and of Some of Its Derivatives. *Arch. Sci. (Geneva)* 24, 153 (1961).

697. Cutler, D., and Powles, J. G. Electron Spin Relaxation and Diffusion in Metal-Ammonia Solutions (Determined) by Microwave Spin Echoes. Proc. Colloq. AMPERE 11, 147 (1962).

698. Cutler, D., and Powles, J. G. Electron Spin Relaxation (E.S.R.) in Metal-Ammonia Solutions. Proc. Phys. Soc. (London) 82, Pt. 1, 1 (1963).

699. Daehler, L. X., Jr. Electron Spin Resonance of Mn<sup>2+</sup> in AgCl. Dissertation Abstr. 24, 352 (1963).

700. Das, M. R., and Venkataraman, B. C<sup>13</sup> Hyperfine Interactions in Semiquinones. Proc. Colloq. AMPERE 11, 426 (1962).

701. Davison, A., Edelstein, N., Holm, R. H., and Maki, A. H. Electron Spin Resonance (E.S.R.) Studies of Four-Coordinate Complexes of Nickel, Palladium, and Platinum Related by Electron Transfer Reactions. J. Am. Chem. Soc. 85, 2029 (1963).

702. Davison, A., Edelstein, N., Holm, R. H., and Maki, A. H. Synthetic and Electron Spin Resonance (E.S.R.) Studies of Six-Coordinate Complexes Related by Electron-Transfer Reactions. Ibid. 86, 2799 (1964).

703. de Boer, E., and Mackor, E. L. Alteration of Line Width in the Electron Spin Resonance (E.S.R.) Spectrum of the Alkali-Metal Radical-Ion Complex of Pyracene. Proc. Chem. Soc., 23 (1963).

704. de Boer, E., and Mackor, E. L. Line Width Alteration in the Electron Spin Resonance (E.S.R.) Spectrum of the Alkali Radical-Ion Complex of Pyracene. J. Am. Chem. Soc. 86, 1513 (1964).

705. de Boer, E., and Mackor, E. L. Second-Order Splitting, Anomalous Relaxation, and Sign of the Coupling Constant in Electron Spin Resonance (E.S.R.) Spectra of Radical Ions. Proc. Colloq. AMPERE 11, 439 (1962).

706. de Grott, M. S., and van der Waals, J. H. Paramagnetic Resonance in Phosphorescent Benzene and Some of Its Derivatives. Ibid., 379 (1962).

707. Degtyarev, L. S., and Ganyuk, L. N. Electron Paramagnetic Resonance (E.P.R.) Spectra of Tetramethylthiuram Disulfide (TMTD) and Its Copper Complex. Vysokomolekul. Soedin. 6, 28 (1964).

708. Dilli, S., and Garnett, J. L. Electron Spin Resonance (E.S.R.) Investigations of Irradiated Carbohydrates. *Nature* 198, 984 (1963).

709. Dischler, B., Raeuber, A., and Schneider, J. Electron Spin Resonance Analysis of Thermally Activated Motional Effects in the ZnS A Centers. *Phys. Status Solidi* 6, 507 (1964).

710. Doorenbos, H. E., and Loy, B. R. Electron Spin Resonance of the N<sub>2</sub>F<sub>4</sub>-NF<sub>2</sub> Equilibrium. *J. Chem. Phys.* 39, 2393 (1963).

711. Dorain, Paul B., and Locker, Donald. Angular Modulation of the Magnetic Field in Electron Paramagnetic Resonance (E.P.R.) Experiments. *Rev. Sci. Instr.* 34, 359 (1963).

712. Douzou, Pierre, Ptak, Marius, and Ropars, Claude. Examination of Optically Excited Amoni Acids by Electron Spin Resonance (E.S.R.) at Very Low Temperature. *Nature* 197, 1105 (1963).

713. Dukan, W., and Schneider, E. E. Electron Spin Resonance (E.S.R.) in n-Type GaAs. *Phys. Letters* 7, 23 (1963).

714. Ehrenberg, Anders. Detailed Electron Spin Resonance (E.S.R.) Spectra of the Free Radicals of FMN and FAD. *Acta Chem. Scand.* 14, 766 (1960).

715. Ehrenberg, Anders, and Eriksson, L. E. Gorn. Electron Spin Resonance (E.S.R.) Study on Flavine Free Radicals in Non-Alkaline Media. *Arch. Biochem. Biophys.* 105, 453 (1964).

716. Emel'yanova, E. N., Karlov, N. V., Manenkov, A. A., Milyaev, V. A., Prokhorov, A. M., Smirnov, S. P., and Shirkov, A. V. E.P.R. (Electron Paramagnetic Resonance) Spectrum and Spin-Lattice Relaxation of Chromium and Ferric Ions in Zinc Tungstate Single Crystals. *Zh. Eksperim. i Teor. Fiz.* 44, 868 (1963).

717. Ershov, B. G., Pikaev, A. K., Glazunov, P. Ya., and Spitsyn, Vikt. I. Electron Spin Resonance (E.S.R.) Spectrum of a Hydrated Electron in Irradiated Frozen Alkaline Solutions. *Dokl. Akad. Nauk SSSR* 149, 363 (1963).

718. Falconer, W. E., and Morton, J. R. Electron Spin Resonance of the XeF Radical. *Proc. Chem. Soc.*, 95 (1963).

719. Farmer, J. B., Hutchinson, D. A., and McDowell, C. A. Electron Spin Resonance Studies of  $\text{NO}_2$  Trapped in Inert Matrixes at Liquid He Temp. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 44-1-44-15 (1961).
720. Faulkner, E. A., and Holman, A. Variable-Coupling Cavity for Electron Spin Resonance Measurements. *J. Sci. Instr.* 40, 205 (1963).
721. Faulkner, E. A., Mitchell, E. W. J., and Whipple, P. W. Electron Spin Resonance (E.S.R.) of Neutron-Irradiated Diamond. *Nature* 198, 981 (1963).
722. Fendell, Julien, Freed, Jack H., and Fraenkel, George K. Solvent Effects in Electron Spin Resonance (E.S.R.) Spectra. *J. Chem. Phys.* 37, 2832 (1962).
723. Fessenden, Richard W. Measurement of Short Radical Lifetimes by Electron Spin Resonance (E.S.R.) Methods. *J. Phys. Chem.* 68, 1508 (1964).
724. Fessenden, Richard W., and Schuler, Robert H. Electron Spin Resonance Studies of Transient Alkyl Radicals. *J. Chem. Phys.* 39, 2147 (1963).
725. Fessenden, Richard W., and Schuler, Robert H. (Electron Spin Resonance) E.S.R. Spectrum of the Cyclohexadienyl Radical. *Ibid.* 38, 773 (1963).
726. Fischer, P. H. H., and Haussr, K. H. Electron Spin Resonance (E.S.R.) of m-Hexaphenyleno Radical Anion. *Z. Naturforsch.* 19a, 816 (1964).
727. Fleurke, K. H., de Jong, J., and Nauta, W. Th. Heat of Dissociation of Hexaphenylethane as Measured by Electron Spin Resonance. *Rec. Trav. Chim.* 82, 713 (1963).
728. Foerster, G. V. Triplet Phosphorescence and Electron Spin Resonance (E.S.R.) Absorption of Some Organic Molecules in Glassy Solutions. *Z. Naturforsch.* 18a, 620 (1963).
729. Forrestal, Lloyd J., and Hodgson, William G. Electron Spin Resonance (E.S.R.) Studies of Irradiated Polypropylene. *J. Polymer Sci. Pt. A* 2, 1275 (1964).

730. Freed, Jack H., and Fraenkel, George K. Alternating Line Widths and Related Phenomena in the Electron Spin Resonance Spectra of Nitro-Substituted Benzene Anions. *J. Chem. Phys.* 41, 699 (1964).

731. Freed, Jack H., and Fraenkel, George K. Anomalous Alternating Linewidths in Electron Spin Resonance (E.S.R.) Spectra. *Ibid.* 37, 1156 (1962).

732. Freed, Jack H., and Fraenkel, George K. Intramolecular Hydrogen Bonding in Electron Spin Resonance (E.S.R.) Spectra. *Ibid.* 38, 2040 (1963).

733. Freed, Jack H., and Fraenkel, George K. Line Widths in Electron Spin Resonance (E.S.R.) Spectra. *Ibid.* 39, 326 (1963).

734. Freed, Jack H., and Fraenkel, George K. Line-Width Studies in Electron Spin Resonance Spectra: The Para and Ortho Dinitrobenzene Anions. *Ibid.* 40, 1815 (1964).

735. Freed, Jack H., and Fraenkel, George K. Theory of Line Widths in Electron Spin Resonance (E.S.R.) Spectra: Motion of Methyl Groups. *J. Am. Chem. Soc.* 86, 3477 (1964).

736. Freed, Jack Hirschel. A Study of Hyperfine Line Widths in Electron Spin Resonance Spectra and the Alternating Line Width Phenomenon. *Dissertation Abstr.* 24, 91 (1963).

737. Friedlander, Henry Z., Saldick, Jerome, and Frink, Charles R. Electron Spin Resonance Spectra in Various Clay Minerals. *Nature* 199, 61 (1963).

738. Fujinaga, Taichiro, Deguchi, Yasuo, and Umemoto, Kisaburo. Electron Spin Resonance Study of Substituted Nitrobenzene Negative Ions Produced by Electroreduction. *Bull. Chem. Soc. Japan* 37, 822 (1964).

739. Fujita, Nobufusa, and Matsumura, On. Electron Spin Resonance (E.S.R.) of Diphenyl- $\beta$ -picryl Hydrazyl (DPPH) in Polymer Solutions. *Mem. Fac. Sci., Kyushu Univ. Ser. B.* 3, 65 (1962).

740. Fujiwara, Shizuo, and Codell, Maurice. Electron Paramagnetic Resonance (E.P.R.) Studies of Titanium(III) Ions With Complexing Compounds. *Bull. Chem. Soc. Japan* 37, 49 (1964).

741. Fujiwara, Shizuo, Nagashima, Kozo, and Codell, Maurice. Mixed Chelate Compounds of Ti(III) as Studied by Electron Paramagnetic Resonance and Spectrophotometry. *Ibid.*, 773 (1964).
742. Gardner, J. H., Hill, M. W., Johanson, C., Larson, D., Murri, W., and Nelson, M. Apparatus for Electron Spin Resonance Studies at Very High Pressures. *Rev. Sci. Instr.*, 34, 1043 (1963).
743. Garif'yanov, N. S., Il'yasov, A. V., and Yablokov, Yu. V. Electron Spin Resonance (E.S.R.) in Liquid and Supercooled Solutions of Some Free Radicals. *Dokl. Akad. Nauk SSSR* 149, 876 (1963).
744. Garif'yanov, N. S., Kucheryavenko, N. S., and Fedotov, V. N. Investigation of Quinquevalent Molybdenum Solutions by the Electron Spin Resonance (E.S.R.) Method. *Ibid.* 150, 802 (1963).
745. Geist, D. Electron Paramagnetic Resonance in Semiconductors. *Festkoerperprobleme* 2, 93 (1963).
746. Gendell, Julien, Freed, Jack H., and Fraenkel, George K. Line Shapes in Electron Spin Resonance Spectra. *J. Chem. Phys.* 41, 949 (1964).
747. Gerson, F., and van Voorst, J. D. W. Low-Temperature Electron Spin Resonance (E.S.R.) Spectra of the Anions of Cycl(3,2,2)-azine and Cycl(3,2,2)azine-1,4-d<sub>2</sub>. *Helv. Chim. Acta* 46, 2257 (1963).
748. Gerson, F., Heilbronner, E., and Boekelheide, V. Electron Spin Resonance (E.S.R.) Spectra of the Radical Ions of Trans-15, 16-dimethyldihydropyrene and Its Semiquinone. *Ibid.* 47, 1123 (1964).
749. Glarum, Sivert H., and Marshall, James H. Electron Spin Resonance (E.S.R.) Study of the Sym-Trinitrobenzene Anion and Related Radicals. *J. Chem. Phys.* 41, 2182 (1964).
750. Gragerov, I. P., Ponomarchuk, M. P., Streiko, V. V., Ganyuk, L. N., and Vysotskii, Z. Z. Formation of Radicals of Benzoquinhydrone and Phenazhydrin on Solid Surfaces as Investigated by Means of Electron Spin Resonance (E.S.R.). *Dokl. Akad. Nauk SSSR* 147, 867 (1962).
751. Griffith, O. Hayes. Electron Spin Resonance and Molecular Motion of the RCH<sub>2</sub>-CHCOOR' Radicals in X-Irradiated Esterurea Inclusion Compounds. *J. Chem. Phys.* 41, 1093 (1964).

752. Guzzo, Anthony V., and Tolin, Gordon. Electron Paramagnetic Resonance (E.P.R.) Studies of Riboflavin and Its Derivatives. I. Isoalloxazine Semiquinones in Acid. *Arch. Biochem. Biophys.* 103, 231 (1963).

753. Guzzo, Anthony V., and Tolin, Gordon. Electron Paramagnetic Resonance (E.P.R.) Studies of Riboflavin and Its Derivatives. II. Alloxazine Semiquinones in Acid. *Ibid.*, 244 (1963).

754. Guzzo, A. V., and Tolin, G. Electron Paramagnetic Resonance (E.P.R.) Studies of Riboflavin and Its Derivatives. III. Isoalloxazine Semiquinones at Neutral and Basic pH. *Ibid.* 105, 380 (1964).

755. Harrah, L. A., Rondeau, R. E., Zakanycz, S., Hale, D., and Dunbar, D. Electron Spin Resonance (E.S.R.) Study of  $\gamma$ -Irradiated Solid Acetonitrile. US At. Energy Comm. ASD-TDR-63-785, 25 pp. 1963.

756. Harriman, John Edward. Electron Spin Resonance Behavior in Systems With Orbital Near Degeneracies. *Dissertation Abstr.* 24, 1848 (1963).

757. Harriman, John E., and Maki, August H. Intramolecular Electron Transfer in Bis(p-nitrophenyl)anions and Its Effect on Electron Spin Resonance Hyperfine Structure. *J. Chem. Phys.* 39, 778 (1963).

758. Harrison, S. E., and Assour, J. M. Electron Spin Resonance of Copper Phthalocyanine. Paramagnetic Resonance, *Proc. Intern. Conf.*, 1st, Jerusalem 2, 855 (1962).

759. Harrison, S. E., and Assour, J. M. Relationship of Electron Spin Resonance (E.S.R.) and Semiconduction in Phthalocyanines. *J. Chem. Phys.* 40, 365 (1964).

760. Haupt, J., and Mueller-Warmuth, W. Investigations of the Electron Spin Relaxation and Hyperfine Structure of Free Radicals in Solution by Dynamic Nuclear Polarization. *Z. Naturforsch.* 17a, 1011 (1962).

761. Haussner, K. H. Reinterpretation of the Wurster's Blue Electron Spin Resonance Spectrum. *Mol. Phys.* 7, 195 (1963-1964).

762. Haesser, K. H., Mongini, L., and van Steenwinkel, R. Electron Spin Resonance (E.S.R.) Spectra of the Terphenyl Anion. *Z. Naturforsch.* 19a, 777 (1964).
763. Hayes, Robert G. The Electron Paramagnetic Resonance (E.P.R.) Spectrum of the  $\text{Cr}(\text{CN})_5\text{NO}_3^+$  Ion. *J. Chem. Phys.* 38, 2580 (1963).
764. Hayes, W., and Twidell, J. W. Paramagnetic Resonance of Divalent Lanthanum in Irradiated  $\text{CaF}_2$ . *Proc. Phys. Soc. (London)* 82, 330 (1963).
765. Heineken, F. W., Bruin, M., and Bruin F. Free Radical Spin Resonance Spectra of Oxindigo. *Tetrahedron* 19, 439 (1963).
766. Henning, J. C. M., and de Waard, C. On the Interpretation of the  $\text{N}^{14}$  Hyperfine Interactions in Electron Spin Resonance Spectra of Heterocyclic Anions. *Phys. Letters* 3, 139 (1962).
767. Hirota, Kozo, Kageyama, Yoichi, and Kuwata, Keiji. Paramagnetic Chemical Species of Triphenylmethane and Diphenylamine Formed on the Surface of Several Oxides. *Bull. Chem. Soc. Japan* 36, 875 (1963).
768. Hirota, Noboru. Spin Distribution in Ketyl Radicals. *J. Chem. Phys.* 37, No. 8, 1884 (1962).
769. Hirota, Noboru, and Weissman, S. I. Spin-Spin Interaction in Dimers of Free Radicals. *Mol. Phys.* 5, 537 (1962).
770. Hirota, Noboru Hutchison, Clyde A., Jr., and Palmer, Patrick. Hyperfine Interactions and Electron Spin Distribution in Triplet-state Naphthalene. *J. Chem. Phys.* 40, 3717 (1964).
771. Hornig, A. W., and Hyde, James S. Paramagnetic Resonance in Triplet Naphthalene at Liquid Helium Temperatures. *Mol. Phys.* 6, 33 (1963).
772. Hsu, Kuang-Chih, Ch'en, Su-min, and T'eng, Yu-Ch'i. Electron Spin Resonance Spectra of Aromatic Amine Free Radicals Stabilized on  $\text{SiO}_2\text{-Al}_2\text{O}_3$  Catalyst. *K'o Hsueh, T'ung Pao*, 49 (1963).

773. Hsu, Kuang-Chih, Huang, Shou-Ling, Tang, Yu-Chi, and Hu, Jih-Heng. Simple E.S.R. (Electron Spin Resonance) Spectrometer. *Hua Hsueh Hsueh Pao* 29, 373 (1963).

774. Huebner, H., Sulimow, J., Wartewig, S., and Windsch, W. Electron Spin Resonance (E.S.R.) of Perdeuterated Triphenylmethane Radicals. *Z. Physik. Chem.* 224, 207 (1963).

775. Hutchings, M. T., and Wolf, W. P. Observation of Paramagnetic g-Value Shifts by Exchange Interactions. *Phys. Rev. Letters* 11, 187 (1963).

776. Hutchison, Clyde A., Jr. The Application of Electron Magnetic Resonance Techniques to the Study of the Phosphorescence of Organic Molecules. *Proc. Colloq. Spectros. Intern.*, 10th, Univ. Maryland, 681 (1962).

777. Hyde, James S., and Maki, August H. Electron Nuclear Double Resonance (E.N.D.O.R.) of a Free Radical in Solution. *J. Chem. Phys.* 40, 3117 (1964).

778. Iida, Yoichi, Kinoshita, Minoru, Sano, Mizuka, and Akamatsu, Hideo. Anomalies in the Temperature Dependences of the Electron Spin Resonance (E.S.R.) Absorption and Electrical Conductivity of an Anion Radical Salt,  $[ (C_6H_5)_3PCH_3 ]^+ (TCNO)_2^-$ . *Bull. Chem. Soc. Japan* 37, 428 (1964).

779. Ikrina, M. A., Il'yasov, A. V., Kozyrev, B. M., Matevosyan, R. O., Ryzhmanov, Yu. M., and Yablokov, Yu. V. Fine Structure of Electron Spin Resonance (E.P.R.) Spectra of  $\alpha, \alpha$ -Diphenyl- $\beta$ -triphenylmethylhydrazyl and Its Derivatives. *Dokl. Akad. Nauk SSSR* 147, 618 (1962).

780. Il'yasov, A. V. Effect of Solvents on the Electron Paramagnetic Resonance (E.P.R.) Spectra of Some Free Radicals. *Zh. Strukt. Khim.* 3, 95 (1962).

781. Il'yukevich, L. A., Poznyak, A. L., and Shagisultanova, G. A. Electron Paramagnetic Resonance (E.P.R.) in Several Compounds of Copper. *Ibid.* 4, 919 (1963).

782. Ingold, K. U., and Morton, J. R. Electron Spin Resonance Spectra of Organic Oxy Radicals. *J. Am. Chem. Soc.* 86, 3400 (1964).

783. Ishizu, Kazuhiko. Electron Spin Resonance (E.S.R.) Studies on Negative Ions of Biphenyl Derivatives. I. E.S.R. Hyperfine Spectra of 4-Methylbiphenyl and p,p'-Bitolyl Mononegative Ions. Bull. Chem. Soc. Japan 36, 938 (1962).
784. Ishizu, Kazuhiko. Electron Spin Resonance Studies on Negative Ions on Biphenyl Derivatives. II. Electron Spin Resonance Hyperfine Spectra of 3-Methyl Biphenyl, m,m'-Bitolyl, 2-Methyl Biphenyl and o,o'-Bitolyl Mononegative Ions. Ibid. 37, 1093 (1964).
785. Ito, Koichi, and Miyagawa, Ichiro. Electron Spin Resonance (E.S.R.) of Irradiated Single Crystals of Alanine: Proton-Deuteron Exchange Reaction of a Free Radical in the Solid State. J. Chem. Phys. 40, 3328 (1964).
786. Ito, Michiya, Okamoto, Toshihiko, and Nagakura, Saburo. Electron Spin Resonance (E.S.R.) and Electronic Spectra of the Anion Radicals of 4-Nitropyridine and 4-Nitropyridine 1-Oxide. Bull. Chem. Soc. Japan 36, 1665 (1963).
787. Jesse, R. E., Biloen, P., Prins, R., van Voorst, J. D. W., and Hoijtink, G. Jr. Hydrocarbon Ions With Triplet Ground States. Mol. Phys. 6, 633 (1963).
788. Johnson, C. S., Jr., Visco, R. E., Gutowsky, H. S., and Hartley, A. M. E.S.R. (Electron Spin Resonance) Spectrum and Spin Densities for the Biquaternary Bipyridyl Radical Cation. J. Chem. Phys. 37, 1580 (1962).
789. Jones, M. Thomas, and Weissman, S. I. Electron Transfer Between Tris(p-nitrophenyl)methyl Radical and Tris(p-nitrophenyl)methide Ion Studied by Electron Spin Resonance Techniques. J. Am. Chem. Soc. 84, 4269 (1962).
790. Jones, M. T., and Chesnut, D. B. Triplet Spin Exchange in Some Ion Radical Salts. J. Chem. Phys. 38, 1311 (1963).
791. Jones, M. T., LaLancette, E. A., and Benson, R. E. E.S.R. (Electron Spin Resonance) of Substituted Cyclobutane Anions. Ibid. 41, 401 (1964).
792. Kaiser, E. T., and Eargle, D. H., Jr. Conjugative Effects of Sulfur in Several Aromatic Anion-Radicals. J. Am. Chem. Soc. 85, 1821 (1963).

793. Kaitmazov, S. D., and Prokhorov, A. M. Electron Paramagnetic Resonance (E.P.R.) Spectra of HO<sub>2</sub>, OH, DO<sub>2</sub>, and OD Radicals. *Fiz. Tverd. Tela* 5, 347 (1963).

794. Kalinowski, Marek K., and Sadlej, Andrzej J. Electron Paramagnetic Resonance. I. Theoretical Principles. *Wiadomosci Chem.* 17, 91 (1963).

795. Kalinowski, Marek K., and Sadlej, Andrzej J. Electron Paramagnetic Resonance. II. Experimental Techniques. *Ibid.* 17 171 (1963).

796. Kallmann, Hartmut P., Gallagher, Jean, and Wotherspoon, Neil. Paramagnetic Resonance of Trapped Electrons in ZnCdS Phosphors. *Proc. Colloq. AMPERE* 11, 414 (1962).

797. Kalmanson, A. E., Kharitonov, I. G., Chetverikov, A. G., and Glyumenfel'd, L. A. Steam-Jet Method of Investigation of the Electronic Paramagnetic Resonance (E.P.R.) Spectra of Free Radicals in Heterogeneous Conditions. *Biofizika* 8, 722 (1963).

798. Karplus, M. Hyperfine Splittings in Aromatic Radicals. *Proc. Intern. Symp. Mol. Struct. Spectry.*, Tokyo, 2 pp. (1962).

799. Karplus, Martin. Theoretical Interpretation of Carbon-13 Hyperfine Interactions in Electron Spin Resonance Spectra. *J. Chem. Phys.* 35, 312 (1961).

800. Karplus, Martin, and Fraenkel, George K. Theoretical Interpretation of Carbon-13 Hyperfine Interactions in Electron Spin Resonance (E.S.R.) Spectra. US Dept. Com., Office Tech. Serv. AD 255,802, 1961.

801. Kashiwagi, Michio, and Kurita, Yukio. Electron Spin Resonance (E.S.R.) of Irradiated Single Crystals of  $\epsilon$ -Caprolactam. *J. Chem. Phys.* 40, 1780 (1964).

802. Kask, N. E., Kornienko, L. S., Prokhorov, A. M., and Fakir, M. Electron Paramagnetic Resonance (E.P.R.) and Spin-Lattice Relaxation of Nd<sup>3+</sup> Impurity Ion in CaWO<sub>4</sub> Single Crystal. *Fiz. Tverd. Tela* 5, 2303 (1963).

803. Kavalerova, E. V., Golubev, V. B., and Evdokimov, V. B. Electron Paramagnetic Resonance (E.P.R.) of Copper Acetylacetate. *Zh. Fiz. Khim.* 37, 226 (1963).

804. Kazakova, V. M., and Syrkin, Ya. K. Electron Paramagnetic Resonance (E.P.R.) Spectra of Aromatic and Aliphatic Metalloketones. *Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go Soveshch.*, Leningrad 2, 106 (1960).

805. Kazakova, V. M., and Syrkin, Ya. K. Hyperfine Structure of the Electron Paramagnetic Resonance (E.P.R.) Spectra of Metal Ketals. *Zh. Strukt. Khim.* 3, 536 (1962).

806. Kazakova, V. M., Syrkin, Ya. K., and Lipkind, G. M. Electron Paramagnetic Resonance (E.P.R.) Spectra of the Potassium Ketyl of 4, 4'-Dimethylbenzophenone. *Ibid.* 4, 915 (1963).

807. Kedzie, R. W., and Kestigian, M. Electron Paramagnetic Resonance (E.P.R.) Determination of Transition Metal Ion Sites and Multiplicity of Rare Earth Ion Sites in CaWO<sub>4</sub>. *Appl. Phys. Letters* 3, 86 (1963).

808. Kessenikh, A. V. Double Nuclear-Electronic Paramagnetic Resonance (ENDOR) and Its Application to the Investigation of Materials. *Tr. Nauchn.-Issled. Fiz.-Khim. Inst.*, 187 (1963).

809. Kessenikh, A. V., and Manenkov, A. A. Dynamic Nuclear Polarization by Saturation of Inhomogeneously Broadened Electron Paramagnetic Resonance Lines. *Fiz. Tverd. Tela* 5, 1143 (1963).

810. Kholmogorov, V. E. Electron Paramagnetic Resonance (E.P.R.) Signals in Phthalocyanine Dyes in the Crystalline State. *Optika i Spektroskopiya* 14, 303 (1963).

811. Kholmogorov, V. E., and Baranov, E. V. Electron Paramagnetic Resonance (E.P.R.) Spectrum of the Photooxidation Products of Diphenylamine in Frozen Solutions at 77°K. *Ibid.*, 827 (1963).

812. Kivelson, Daniel. Theory of Nuclear Hyperfine Broadening of Electron Spin Resonance (E.S.R.) Lines in Liquids. *J. Chem. Phys.* 41, 1904 (1964).

813. Koenig, E., and Fischer, H. Electron Spin Resonance (E.S.R.) Studies on the Anion Radical of 2,2'-Dipyridyl. *Z. Naturforsch.* 17a, 1063 (1962).
814. Kokin, A. A. Effect of the Anisotropy of the g factor of Molecules on the Width of Electron Paramagnetic Resonance (E.P.R.) Lines in Solutions. *Zh. Strukt. Khim.* 5, 217 (1964).
815. Kohin, Roger P., Mueller, K. A., and Hoegl, H. Electron Spin Resonance (E.S.R.) in the Carbazole-Chloranil Charge Transfer Complex. *Helv. Phys. Acta* 35, 255 (1962).
816. Kolker, P. L., and Waters, W. A. Electron Spin Resonance (E.S.R.) Spectra of Unstable Radicals Formed by the Reduction of Phenol-Indophenols. *Chem. Ind. (London)*, 1205 (1963).
817. Kolker, P. L., and Waters, William A. Radical-Anions of Para-Substituted Aromatic Nitro Compounds. *J. Chem. Soc.*, 1136 (1964).
818. Kon, H. The Quinquevalent Chromium Compounds (Examined) by E.S.R. (Electron Spin Resonance) and Optical Spectra. *J. Inorg. Nucl. Chem.* 25, 933 (1963).
819. Kon, Hideo. E.S.R. (Paramagnetic Resonance) Study of Quinquevalent Cr Complexes. *Bull. Chem. Soc. Japan* 35, 2054 (1962).
820. Kottis, Philemon, and Lefebvre, Roland. Calculation of the Electron Spin Resonance Line Shape of Randomly Oriented Molecules in a Triplet State. I. The  $\Delta m = 2$  Transition With a Constant Line Width. *J. Chem. Phys.* 39, 393 (1963).
821. Kottis, Philemon, and Lefebvre, Roland. Calculation of the Electron Spin Resonance (E.S.R.) Line Shape of Randomly Oriented Molecules in a Triplet State. II. Correlation of the Spectrum With the Zero-Field Splittings. Introduction of an Orientation-Dependent Line Width. *Ibid.* 41, 379 (1964).
822. Kozyrev, B. M., Yablokov, Yu. V., Matevosyan, R. O., Ikrina, M. A., Il'yasov, A. V., Ryshmanov, Yu. M., Stashkov, L. I., and Shatrukov, L. F. Electron Paramagnetic Resonance (E.P.R.) of  $\alpha,\alpha$ -Diphenyl- $\beta$ -picrylhydrazyl Derivatives. *Optika i Spektroskopiya* 15, 625 (1963).

823. Kramer, Klaus D., and Mueller-Warmuth, Werner. A 3000-M Electron Resonance Spectrometer for the Determination of Radical Concentrations at Temperatures Between -160 and +1 0°. *Z. Angew. Phys.* 16, 281 (1963).
824. Kravtsov, N. V., Lazukin, V. N., and Chekalin, N. V. Spin Induction in Electron Spin Resonance. *Dokl. Akad. Nauk SSSR* 150, 1267 (1963).
825. Kravtsov, N. V., Lazukin, V. N., and Shanditsev, V. A. Multiquantum Transitions in Electron Spin Resonance (E.S.R.). *Ibid.* 151, 87 (1963).
826. Krishnaji, and Misra, B. N. Electron Spin Resonance Absorption in Recrystallized Free Radicals at Low Fields. *J. Chem. Phys.* 41, 1027 (1964).
827. Kurita, Yukio. Electron Spin Resonance Studies of Fast Reactions. *Kagaku To Kogyo* 17, 984 (1964).
828. Kuwata, Keiji, and Hirota, Kozo. Electron Spin Resonance of the Anions of Aromatic Vinyl Compounds. *Proc. Intern. Symp. Mol. Struct. Spectry.*, Tokyo, 4 pp. (1962).
829. Laederich, Thierry, and Traynard, Philippe. Electron Paramagnetic Resonance in Oxidation Products of Aniline. *Compt. Rend.* 257, 84 (1963).
830. Laeler, Ronald G., Bolton, James R., Fraenkel, George K., and Brown, Thomas H. Orbital Degeneracy and the Electron Spin Resonance Spectrum of the Benzene-1-d Negative Ion. *J. Am. Chem. Soc.* 86, 520 (1964).
831. Lagercrantz, Carl, and Yhland, Margareta. Free Radicals in the Reaction of Glutathione and Ascorbic Acid. *Acta Chem. Scand.* 17, 1677 (1963).
832. Lamotte, Bernard, Rassat, Andre, and Servoz-Gavin, Pierre. Study of the Positive Ion Radical of Phenoxanthiine Resonance. *Compt. Rend.* 255, 1508 (1962).
833. Landgraf, W. C. Electron Paramagnetic Resonance (E.S.R.) Studies of Free Radicals in Solution. US Dept. Com., Office Tech. Serv., AD 265,214. 1961.

834. Lapshin, N. M., Ovcharenko, N. I., and Khidekel, M. L. The Paramagnetic Character of Polycyclopentadiene. *Zh. Strukt. Khim.* 5, 305 (1964).

835. Lebedev, Ya. S. Analysis of Asymmetric Electron Paramagnetic Resonance (E.P.R.) Lines in the Small Axial Anisotropy Case. *Ibid.* 3, 151 (1962).

836. Lebedev, Ya. S., Chernikova, D. M., Tikhomirova, N. N., and Voevodskii, V. V. *Atlas of Electron Spin Resonance Spectra: Theoretically Calculated Multicomponent Symmetrical Spectra.* New York: Consultants Bureau. 1963.

837. Lefebvre, Roland, Maruani, Jean, and Marx, Rose. Electron Spin Resonance (E.S.R.) Evidence of a Distortion of Diphenylpicrylhydrazyl in a Crystalline Medium. *J. Chem. Phys.* 41, 585 (1964).

838. Levy, Donald H., and Myers, Rollie J. Electron-Spin Resonance Spectrum of the Radical Anion of 1,3-Butadiene in Liquid Ammonia. *Ibid.*, 1062 (1964).

839. Locher, P. R., and Geschwind, S. Electron Nuclear Double Resonance (E.N.D.O.R.) of  $^{61}\text{Ni}$  in  $\text{Al}_2\text{O}_3$  and Variation of Hyperfine Structure Through an Inhomogeneous Line Due to Random Crystal Fields. *Phys. Rev. Letters* 11, 333 (1963).

840. Lontz, Robert Jan. Fluorine Hyperfine Interaction in Electron Spin Resonance of Free Radicals. *Dissertation Abstr.* 23, 3444 (1963).

841. Low, William. *Paramagnetic Resonance in Solids.* New York: Academic Press. 1960.

842. Lucken, E. A. C. The Electron Spin Resonance (E.S.R.) Spectra and Electronic Structure of Phosphobetaine Radicals. *J. Chem. Soc.*, 5123 (1963).

843. Luckhurst, G. R., and Orgel, L. E. Electron Spin Resonance Spectra of 2,2,5,5-Tetramethyl-3,4-hexanedione and Benzil Anions. *Mol. Phys.* 7, 297 (1963-1964).

844. Ludwig, Peter, Layloff, Thomas, and Adams, Ralph N. Solvent Effects on Hyperfine Coupling Constants in Electron Paramagnetic Resonance (E.P.R.) Spectra. *J. Am. Chem. Soc.* 86, 4568 (1964).

845. Lukiewicz, St. A method of Measuring the Intensity of Electron Spin Resonance (E.S.R.) Absorption. *Experientia* 19, 491 (1963).
846. Lynden-Bell, Ruth M. The Line Shapes of the Electron Spin Resonance Spectrum of a System of Interacting Triplets. *Mol. Phys.* 8, 71 (1964).
847. Lyndin, E. A., and Filippov, K. I. Electron Paramagnetic Resonance Radiospectrometer. *Priborostroenie*, No. 2, 25 (1963).
848. McConnell, H. M., Pooley, D., and Bradbury, A. The Paramagnetic Resonance of Wurster's Blue Perchlorate. *Proc. Natl. Acad. Sci. US* 48, 1480 (1962).
849. McDonald, C. C. Electron Paramagnetic Resonance (E.P.R.) Spectra of SH, SD, and SO Radicals in the Gaseous State. *J. Chem. Phys.* 39, 2587 (1963).
850. McDowell, Charles A. Spin Resonance and Hyperfine Interaction. *Rev. Mod. Phys.* 35, 528 (1963).
851. McDowell, C. A., Paulus, K. F., and Rowlands, J. R. Electron Spin Resonance (E.S.R.) Spectra of Some Diazine Radical Anions. *Proc. Chem. Soc.*, 60 (1962).
852. McGarvey, B. R. Electron Spin Resonance (E.S.R.) and Optical Spectrum of Potassium Perchromate. *J. Chem. Phys.* 37, 2001 (1962).
853. Mackey, John H., Jr. An E.P.R. (Electron Paramagnetic Resonance) Study of Impurity-Related Color Centers in Germanium-Doped Quartz. *Ibid.* 39, 74 (1963).
854. Mahlab, E., Volterra, V., Low, W., and Yariv, A. Orthorhombic Electron Spin Resonance Spectrum of U<sup>3+</sup> in CaF<sub>2</sub>. *Phys. Rev.* 131, 920 (1963).
855. Mandel, Morton. Paramagnetic Resonance of Yd<sup>+++</sup> in Yttrium Oxide. *Appl. Phys. Letters* 2, 197 (1963).
856. Marchand, Andre, Delhaes, Pierre, and Zanchetta, Jean. Electron Paramagnetic Resonance (E.P.R.) of Carbon in Anthracene and Acridine. *J. Chim. Phys.* 60, 688 (1963).

857. Maruyama, Kazuhiro, Tanikaga, Rikuhei, and Goto, Ryozo. Electron Spin Resonance (E.S.R.) of Ortho-Substituted Benzo-phenone Ketals. Bull. Chem. Soc., Japan 36, 1141 (1963).
858. Marx, Rose, Leach, Sydney, and Horani, Marcel. Electronic Excitation of a Stream of Molecules of Water and Its Deuterated Isotopes by Electronic Paramagnetic Resonance (E.P.R.) of Products condensed at 77°K. J. Chim. Phys. 60, 726 (1963).
859. Messiaen, A. M. (Electron) Resonances in Several Cylindrical Plasmas. Physica 20, 1117 (1963).
860. Milevskaya, I. S., and Vol'kenshtein, M. V. Determination of the Configuration of Macroradicals From Electron Paramagnetic Resonance (E.P.R.) Spectra. II. Optika i Spektroskopiya, Akad. Nauk SSSR, Otd. Fiz.-Nat. Nauk, Sb. Statei 2, 70 (1963).
861. Misra, B. N. Hyperfine Structure in the Electron Spin Resonance (E.S.R.) Spectrum of Picryl-N-aminocarbazyl Solutions. J. Phys. Soc., Japan 19, 1906 (1964).
862. Moebius, K., and Schneider, F. Electron Spin Resonance Investigation of DPPH-Hydroperoxide Solutions. Z. Naturforsch. 18a, 428 (1963).
863. Morigaki, Kazuo. Electron Spin Resonance (E.S.R.) of Nd<sup>3+</sup> in Cadmium Sulfide Single Crystals. J. Phys. Soc., Japan 18, 1636 (1963).
864. Morokuma, Kaiji, Ohnishi, Shunichi, Masuda, Takao, and Fukui, Kenichi. Theoretical Assignment of the Electron Spin Resonance Spectra of Cyclohexadienyl and Phenyl Radicals. Bull. Chem. Soc., Japan 30, 1228 (1963).
865. Morton, J. R. Electron Spin Resonance in Irradiated Glycine Crystals. J. Am. Chem. Soc. 86, 2325 (1964).
866. Morton, J. R. Electron Spin Resonance Spectra of Oriented Radicals. Chem. Rev. 64, 453 (1964).
867. Morton, J. R. E.P.R. (Electron Paramagnetic Resonance) Spectrum of PF<sub>4</sub><sup>-</sup> in Irradiated NH<sub>4</sub>PF<sub>6</sub>. Can. J. Phys. 41, 706 (1963).

868. Mueller, Adolf, Schambra, Philip E., and Pietsch, Eleonore. Comparative Electron Spin Resonance (E.S.R.) Measurements of Radical Production in Amino Acids by  $^{210}\text{Po}$   $\alpha$ - and  $^{60}\text{Co}$   $\gamma$ -Radiation. *Intern. J. Radiation Biol.* 7, 587 (1963).
869. Mueller, K. A., and Schneider, J. Conduction Electron Spin Resonance (E.S.R.) in Group II-VI Semiconductors and Phosphors. *Phys. Letters* 4, 288 (1963).
870. Muller-Warmuth, W. Electron Spin Resonance in Liquids: Quantitative Determination of the Action of Molecular Dissolved Oxygen. *Z. Naturforsch.* 18a, 1001 (1963).
871. Nador, Bela. Electron Spin Resonance (E.S.R.) Investigations in the System Vanadium Pentoxide-Phosphorus Pentoxide. *Acta Chim. Acad. Sci. Hung.* 40, 1 (1964).
872. Nakamura, Kazuo, and Deguchi, Yasuo. (Electron Spin Resonance) E.S.R. Spectrum of the Phthalonitrile Anion Radical. *Bull. Chem. Soc., Japan* 36, 359 (1963).
873. Narasimhamurty, A. Electron Paramagnetic Resonance (E.P.R.) in Single Crystals: III. Copper Sulfate Pentahydrate. *Indian J. Pure Appl. Phys.* 1, 275 (1963).
874. Nechtschein, Maxime. The Nature of the Paramagnetic Centers Detected by Electron Spin Resonance (E.S.R.) in Conjugated Polymers. *J. Polymer Sci. Pt C No.* 4, 1367 (1964).
875. Nedoshivin, Yu. N., and Kasatochkin, V. I. Electron Paramagnetic Resonance (E.P.R.) in Chemically Carbonized Substances. *Zh. Khim. Fiz.* 37, 1162 (1963).
876. Nekrasov, L. I. Electron Paramagnetic Resonance (E.P.R.) of Absorbed Chlorophyll. *Vestn. Mosk. Univ., Ser. II. Khim.* 17, 73 (1962).
877. Nicolau, Claude. Electron Spin Resonance Investigations on Supported Platinum-Catalysis. *Rev. Chim., Acad. Rep. Populaire Roumaine* 7, No. 1, 355 (1962).

878. Nishiguchi, Hiroaki, Nakai, Yasuto, Nakamura, Kazuo, Deguchi, Yasuo, and Takaki, Hideo. Electron Spin Resonance (E.S.R.) Spectra of the Mononegative Ions of o-, m-, and p-Terphenyl. *Rev. Phys. Chem., Japan* 32, 57 (1963).

879. Nordio, P. L., Giacometti, G., and Favero, P. Electron Spin Resonance (E.S.R.) Spectra of Negative Ions of Some Benzo-phenone Derivatives. *Ric. Sci., Rend. Sez. A* 3, 107 (1963).

880. Nordio, P. L., Pavan, M. V., and Rigatti, G. M. O. Calculation of Hyperfine Structure in Azulene Anion Radical. *Ibid.*, 851 (1963).

881. Ohkura, Hiroshi, and Murase, Kazuo. Electron Spin Resonance (E.S.R.) of Electron-Excess Color Centers in KCl Crystals. *J. Phys. Soc., Japan* 18, Suppl. 2, 255 (1963).

882. Ohnishi, Shunichi, and Nitta, Isamu. Electron Spin Resonance (E.S.R.) Study of Free Radicals Produced in Irradiated Cyclopentadiene and Cyclohexene: The Cyclopentadienyl and Cyclohexenyl Radicals. *J. Chem. Phys.* 39, 2848 (1963).

883. Ohnishi, Shunichi, Tanei, Tadayoshi, and Nitta, Isamu. Electron Spin Resonance (E.S.R.) Study of Free Radicals Produced by Irradiation in Benzene and Its Derivatives. *Ibid.* 37, 2402 (1962).

884. Otomo, Yoshiro, and Kasai, Paul H. Electron Paramagnetic Resonance (E.P.R.) Studies of Luminescent Centers and Traps in Self-Activated ZnS Phosphors. *J. Phys. Soc., Japan* 18, Suppl. 2, 295 (1963).

885. Overall, D. W. E.P.R. Spectrum of Irradiated Oriented Polytetrafluoroethylene. *J. Chem. Phys.* 38, 2448 (1963).

886. Owen, J. Spin Resonance of Ion Pairs in Crystal Lattices. *J. Appl. Phys.* 33, 355 (1962).

887. Owen, John. (Electron) Paramagnetic Resonance (E.P.R.). *Chem. Co-Ord. Compds., Symp.*, Rome, 430 (1957).

888. Ozols, A. Absorption From Solutions by Clay Colloids of Heavy Metals Studied by the Method of Electron Paramagnetic Resonance (E.P.R.). *Fiz. Metody, Issled. Osuda, Porod, i Mineraloy, Akad. Nauk SSSR*, 178 (1962).

889. Panfilov, V. N. Electron Paramagnetic Resonance (E.P.R.) Spectra of the Radicals  $\text{HO}_2$  and  $\text{DO}_2$  Obtained by Freezing at 77°K Rarefied Flame Products. *Kinetika i Kataliza* 5, 211 (1964).
890. Pannell, J. Solvent Effects in the Electron Spin Resonance Spectra of Nitric Oxide Radicals and Para-Substituted Nitrobenzene Anions. *Mol. Phys.* 7, 317 (1963-1964).
891. Pannell, J. Solvent Effects in the Electron Spin Resonance Spectra of Para-Substituted Nitrobenzene Anions. II. *Ibid.*, 599 (1963-1964).
892. Partishii, G. B., Zhidomirov, G. M., and Kazanski, V. B. Electron Paramagnetic Resonance Spectrum of the Methyl Radical, Adsorbed on the Surface of Silica Gel. *Zh. Strukt. Khim.* 4, 364 (1963).
893. Pearson, J. T., Smith, P., and Smith, T. C. The Electron Paramagnetic Resonance (E.P.R.) Spectra of the 2-Cyano-2-propyl Radical and Related Species. *Can. J. Chem.* 42, 2022 (1964).
894. Pier, E., and Tuttle, T. R., Jr. Electron Spin Resonance (E.S.R.) of Alkylated Benzene Anions. US Dept. Com., Office Tech. Serv., AD 262, 847, 1961.
895. Piette, L. H., Ludwig, Peter, and Adams, Ralph N. Electron Paramagnetic Resonance (E.P.R.) of Aromatic and Aliphatic Nitro Anions in Aqueous Solution. *J. Am. Chem. Soc.* 84, 4212 (1962).
896. Pivovarov, S. P. Measurement and Stabilization of Heterogeneous Magnetic Fields Based on Electron Paramagnetic Resonance (E.P.R.). *Izv. Akad. Nauk SSSR, Ser. Fiz.* 27, 953 (1963).
897. Pivovarov, S. P., Firsov, E. P., Yasnilo, O. N., and Latyshev, G. D. A Comparison of Schemes for the Detection of Electron Spin Resonance (E.S.R.). *Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR* 6, 119 (1963).
898. Pokhedenko, V. D., Ganyuk, L. N., Yakovleva, E. A., Shatenshtein, A. I., and Brodskii, A. I. The Electron Paramagnetic Resonance (E.P.R.) Spectrum and Rearrangement of the Radical Formed in the Oxidation of  $\text{CD}_3$ -Ionol. *Dokl. Akad. Nauk SSSR* 148, 1314 (1963).
899. Pontinen, Richard Ernest. Electron Spin Resonance Studies of n-Type Germanium. Univ. Microfilms, Order No. 63-4330.

900. Rahn, R. O., Longworth, J. W., Eisinger, J., and Shulman, R. G. Electron Spin Resonance (E.S.R.) and Luminescence Studies of Excited States of Nucleic Acids. Proc. Natl. Acad. Sci. US 51, 1299 (1964).
901. Rajan R. Absolute Intensity of Electron Spin Resonance (E.S.R.) Absorption of Cupric Ammonium Chloride Single Crystals. J. Sci. Ind. Res. ZIB, 445 (1962).
902. Randall, Edward W. Electron Spin and Nuclear Spin Resonance Spectroscopy. US Dept. Com., Office Tech. Serv., AD 263, 735, 1961.
903. Razuvaev, G. A., Khidokel, M. L., and Berlina, V. B. A Study of Structure of Organic Compounds by Means of Electron Paramagnetic Resonance (E.P.R.). Dokl. Akad. Nauk SSSR 145, 1071 (1962).
904. Reddoch, A. H. Anomalous Effects in Electron Paramagnetic Resonance Spectra of the Azulene Anion. J. Chem. Phys. 41, 444 (1964).
905. Redhardt, A. Measuring Techniques and Applications of Electron Resonance Spectroscopy in Biophysics. Physikertag. Heidelberg, Hauptvortraege Jahrestag. Verbandes Deut. Physik. Ges., 106 (1962).
906. Rieger, Philip H., and Fraenkel, George K. Analysis of the Electron Spin Resonance (ESR) Spectra of Aromatic Nitrosubstituted Anion Radicals. J. Chem. Phys. 39, 609 (1963).
907. Rieger, Philip H., and Fraenkel, George K. Electron Spin Resonance (E.S.R.) Spectra of Carbonyl Anion Radicals. Ibid. 37, 2811 (1962).
908. Rieger, Philip H., and Fraenkel, George K. Spin-Density Distribution in Nitrile Anion Radicals. Ibid., 2795 (1962).
909. Rundel, W., and Scheffler, K. Electron Paramagnetic Resonance (E.P.R.) Investigations on Substituted Thianthrenes. Tetrahedron Letters, 993 (1963).
910. Ryzhmanov, Yu. M., Yablokov, Yu. V., Kozyrev, B. M., Matevosyan, R. O., and Stashkov, L. I. Electron Paramagnetic Resonance in Meta-Substituted  $\alpha,\alpha$ -Diphenyl- $\beta$ -picrylhydrazyls. Dokl. Akad. Nauk SSSR 156, 106 (1964).

911. Saito, Eiichi. Electron Spin Resonance Studies of Gamma-Irradiated Ferrocene. US At. Energy Comm. BNL-6472, 1962.
912. Sakudo, Tsunetaro. Electron Spin Resonance (E.S.R.) of Fe<sup>3+</sup> at Low Temperatures. J. Phys. Soc., Japan 18, 1626 (1963).
913. Salovey, R., Shulman, R. G., and Walsh, W. M., Jr. Electron Spin Resonance (E.S.R.) of Irradiated DNA. J. Chem. Phys. 39, 839 (1963).
914. Samitov, Yu. Yu., and Lebedev, O. L. Electron Paramagnetic Resonance (E.P.R.) of 2,2,6,6-Tetramethylpentamethylene Nitrogen Oxide Free Radicals. Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go Soveshch., Leningrad 2, 103 (1960).
915. Sane, Krishna Vishnu. Isotropic and Anisotropic Hyperfine Effects in the Electron Spin Resonance Spectra of 2,2-Diphenyl-1-picrylhydrazyl and Other Closely Related Organic Free Radicals. Univ. Microfilms, Order No. 63-4129.
916. Sane, K. V., and Weil, J. A. Paramagnetic Resonance of Hydrazyl-Type Radicals in Viscous Media. Proc. Colloq. AMPERE 11, 431 (1962).
917. Sauzade, Michel, Pontnau, Jean, and Girard, Bernard. An Electron Resonance Spectrometer (Which Operates) at Millimeter Wavelengths. Compt. Rend. 258, 4458 (1964).
918. Scheffler, Klaus, and Stegmann, Hartmut B. A Simple Procedure for Determination of Relative g Factors of Free Radicals. Ber. Busenges. Physik. Chem. 67, 864 (1963).
919. Schieser, David W., and Tuck, L. Dallas. Free Radical Studies by Electron Spin Resonance of Some Derivatives of Phenothiazine. J. Pharm. Sci. 51, 694 (1962).
920. Schneider, F., and Moebius, K. Evaluation of the Electron Paramagnetic Resonance Spectra of Organic Radicals. Z. Naturforsch. 18b, 1111 (1963).
921. Schoffa, G. Electron Spin Resonance (E.S.R.) in Hemin, Hematin, and Hemoglobin at 4.2°K. Nature 203, 640 (1964).

922. Seidel, H. Electron Spin Resonance (E.S.R.) and Electron-Nuclear-Double Resonance (E.N.D.O.R.) of Silver Atoms in a Potassium Chloride Lattice. *Phys. Letters* 6, 150 (1963).

923. Semenov, A. G. Electron Paramagnetic Resonance Spectrometers. *Pribory i Tekhn. Eksperim.* 7, No. 5, 5 (1962).

924. Shida, Shoji. Electron Spin Resonance Absorption of Organic Compounds. *Yuki Gosei Kagaku Kyohai Shi* 20, 897 (1962).

925. Shine, H. J., Dais, C. F., and Small, R. J. Ion Radicals. II. The E.S.R. (Electron Spin Resonance) Spectra of 2,7-Dimethyl- and 2,7-Dichlorothianthrene in Concentrated Sulfuric Acid. *J. Chem. Phys.* 38, 569 (1963).

926. Shine, K. J., Dais, C. F., and Small, R. J. Ion Radicals. IV. The Electron Spin Resonance (E.S.R.) Spectra of Substituted Thianthrenes in Sulfuric Acid Solution. *J. Org. Chem.* 29, 21 (1964).

927. Shioji, Yugi, Ohnishi, Shunichi, and Nitta, Isamu. Electron Spin Resonance (E.S.R.) Study of Irradiated Acrylic Acid and Reaction of the Produced Radical. *J. Polymer Sci. Pt. A* 1, 3373 (1963).

928. Shuvalov, V. F., Lebedev, Ya. S., Tsepalov, V. F., and Shlyapintokh, V. Ya. Electron Paramagnetic Resonance (E.P.R.) Spectra of Peroxide Radicals in the Liquid Phase. *Zh. Fiz. Khim.* 38, 1287 (1964).

929. Siegel, Seymour, and Eisenthal, Kenneth B. Energy Transfer Between Aromatic Molecules. *J. Chem. Phys.* 38, 2785 (1963).

930. Sierro, Jerome. Electron Paramagnetic Resonance (E.P.R.) of  $Gd^{3+}$  in  $CaF_2$ ,  $SrF_2$ , and  $BaF_2$ . *Helv. Phys. Acta* 36, 505 (1963).

931. Silverstein, S. D. Influence of Electron Interactions on Metallic Properties. II. Electron Spin Paramagnetism. *Phys. Rev.* 130, 1703 (1963).

932. Singer, J. R. Exchange-Narrowed Electron Spin Resonance (E.S.R.) Absorption Lines at Low and Intermediate Frequencies. Paramagnetic Resonance, Proc. Intern. Conf., 1st, Jerusalem 2, 577 (1962).

933. Singer, L. S., and Waggoner, G. Electron Spin Resonance (E.S.R.) in Polycrystalline Graphite. *J. Chem. Phys.* 37, 1812 (1962).

934. Skorokhodov, I. I., Golubev, V. B., Nedrasov, L. I., Evdokimov, V. B., and Kobozev, N. I. Higher Hydrogen Peroxide and Frozen Radicals. V. Electron Paramagnetic Resonance (E.P.R.) Study of Peroxide-Radical Condensates. *Zh. Fiz. Khim.* 36, 93 (1962).

935. Slough, W. Electron Spin Resonance (E.S.R.) and Absorption Spectra of Semiconductor Complexes of Tetracyanoethylene (TCNE). *Trans. Faraday Soc.* 59, 2445 (1963).

936. Smaller, B., and Remko, J. R. Electron Paramagnetic Resonance (E.P.R.) Studies of Triplet States and Energy Transfer. US At. Energy Comm. TID-17213, 11 pp. 1962.

937. Sohma, Junkichi. Electron Spin Resonance (E.S.R.) Desaturation Effect of Lifetime of Free Radicals in Chemical Reactions. *Mem. Fac. Eng., Hokkaido Univ.* 11, 397 (1963).

938. Solodovnikov, S. P., and Chernyshev, E. A. Electron Paramagnetic Resonance (E.P.R.) Spectra of Anions of Substituted Aromatic Compounds. I. E.P.R. Spectra of Anions of Trialkylsilylbenzenes and Trialkylsilylalkylbenzenes. *Zh. Strukt. Khim.* 3, 665 (1962).

939. Spackman, J. W. C. Electron Spin Resonance (E.S.R.) of Charge Carriers in Carbon Black. *Colloq. Nationaux Centre Natl. Rech. Sci. No. 24*, 51 (1963).

940. Starmires, Dennis N., and Turkevich, John. Electron Paramagnetic Resonance (E.P.R.) in Some Molecular Charge Transfer Complexes. *J. Am. Chem. Soc.* 85, 2557 (1963).

941. Stauff, J., Huster, H. J., Lohmann, F., and Schmidkunz, H. Chemiluminescence of Oxidation Reactions. V. Electron Spin Resonance (E.S.R.) and Chemiluminescence of O<sub>2</sub>H and OH. *Z. Physik. Chem.* 40, 64 (1964).

942. Steinberger, Naomi, and Fraenkel, George K. Electron Spin Resonance (E.S.R.) of the Acetophenone and Benzaldehyde Anion Radicals. *J. Chem. Phys.* 40, 723 (1964).

943. Stone, Ellery W., and Maki, August H. Electron Spin Resonance (E.S.R.) Spectrum of Diquinone Anion. *Ibid.* 41, 284 (1964).
944. Stone, Ellery W., and Maki, August H. Electron Spin Resonance (E.S.R.) Study of Polyazine Anions. *Ibid.* 39, 1635 (1963).
945. Stone, Ellery W., and Maki, August H. F.S.R. Study of Rotational Isomerism in Substituted Benzaldehyde Anions. *Ibid.* 38, 1999 (1963).
946. Stone, Ellery W., and Maki, August H. Hindered Internal Rotation and Electron Spin Resonance (E.S.R.) Spectroscopy. *Ibid.*, 1254 (1963).
947. Stone, T. J., and Waters, William A. Aryloxy Radicals. I. Electron Spin Resonance (E.S.R.) Spectra of Radicals From Some Substituted Monohydric Phenols. *J. Chem. Soc.*, 213 (1964).
948. Stoodley, L. G. Long Cavities for Aqueous Samples in an Electron Spin Resonance Spectrometer. *Nature* 198, 1077 (1963).
949. Strauss, Herbert Leopold. Studies of Paramagnetic Resonance Spectra of Some Negative Ions in Solution. Univ. Microfilms, Order No. 62-4251.
950. Strauss, Herbert L., Katz, Thomas J., and Fraenkel, George K. Electron Spin Resonance (E.S.R.) Studies of the Cyclooctatetraenyl Anions. *J. Am. Chem. Soc.* 85, 2360 (1963).
951. Strom, E. Thomas, and Russell, Glen A.  $^{13}\text{C}$  Hyperfine Structure in the Electron Spin Resonance Spectrum of Cyclohexane-1,2-dione Radical Anion. *J. Chem. Phys.* 41, 1514 (1964).
952. Sullivan, Patricia J., and Koski, W. S. An Electron Spin Resonance (E.S.R.) Study of Free Radicals in Untraviolet-Irradiated Ethanol at 77°K. *J. Am. Chem. Soc.* 86, 159 (1964).
953. Sullivan, Sister Patricia J., and Koski, W. S. An Electron Spin Resonance Study of the Relative Stabilities of Free Radicals Trapped in Irradiated Methanol at 77°K. *Ibid.* 85, 384 (1963).
954. Sutcliffe, Brian T. Hyperfine Electron Spin Resonance Spectrum of the  $\text{NH}_2$  Free Radical. *J. Chem. Phys.* 39, 3322 (1963).

955. Svirskii, M. S. The Paramagnetism of Free Electrons. *Fiz. Metal. i Metalloved.* 15, 635 (1963).

956. Syrkin, Ya. K., and Kazakova, V. M. Structure of Anions of Aromatic Hydrocarbons. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 382 (1963).

957. Tench, A. J. An Electron Spin Resonance(E.S.R.) Study of Irradiated Quaternary Ammonium Halides. US At. Energy Comm. BNL-5559, 1960.

958. Tench, A. J. Electron Spin Resonance (E.S.R.) Spectra of Unsaturated Radicals in Irradiated Tetraalkyl Ammonium Halides. *Nature* 198, 578 (1963).

959. Theobald, Jean Gerard. Resonance and Electronic Paramagnetic Relaxation. *Ann. Phys.* 7, 585 (1962).

960. Theobald, J. G., and Uebersfeld, J. Structure of Inhomogeneous Electron Resonance Lines. *Proc. Colloq. AMPERE* 11, 445 (1962).

961. Thom, H. G., and Nicolau, Cl. Electron Resonance Studies on Nucleic Acids and Enzymes. *Ber. Arbeitstagung Biophys. Physik. Ges. Deut. Demokrat. Rep.* 5, Berlin, 67 (1960).

962. Thomas, J. R. Electron-Spin Resonance Study of Iminoxy Free Radicals. *J. Am. Chem. Soc.* 86, 1446 (1964).

963. Thomson, Colin. Electron Spin Resonance (E.S.R.) Studies of Triplet States in Plastics: Effect of Temperature on the Spectra. *J. Chem. Phys.* 41, 1 (1964).

964. Tikhomirova, N. N. Application of the Electron Spin Resonance Method in Chemistry. Some New Phenomena in Electron Transfer. *Arch. Sci.* 14, 146 (1961).

965. Tikhomirova, N. N., and Chernikova, D. M. Electron Paramagnetic Resonance of Solid Phthalocyanines. *Zh. Strukt. Khim.* 3, 335 (1962).

966. Tkach, V. K., and Komar, I. N. Radiospectroscope for Studying the Spectra of Electron Paramagnetic Resonance (E.P.R.) of Biological Material at Different Temperatures. *Uch. Zap. Khar'kovsk. Gos. Univ.* 121, Tr. Radiofiz. Fak. No. 5, 172 (1962).

967. Tolkachev, V. A., Chkheidze, I. I., and Buben, N. Ya. Electron Paramagnetic Resonance (E.P.R.) Spectrum of Benzyl Radicals. Dokl. Akad. Nauk SSSR 147, 643 (1962).

968. Tolkachev, V. A., Chkheidze, I. I., and Buben, N. Ya. Electron Paramagnetic Resonance (E.P.R.) Spectrum of Phenyl Radicals. Zh. Strukt. Khim. 3, 709 (1962).

969. Trozzolo, A. M., Murray, R. W., and Wasserman, E. Electron Paramagnetic Resonance (E.S.R.) of Phenylmethlene and Bi-phenylmethlene: Luminescent Reaction Associated With a Ground-State Triplet Molecule. J. Am. Chem. Soc. 84, 4990 (1962).

970. Ueda, Hisashi. Electron Spin Resonance (E.S.R.) of Some Free Radicals and Related Negative Ions. J. Phys. Chem. 68, 1304 (1964).

971. Ueda, Shinichi. Dibenzo-p-dioxin (Diphenylene Dioxide) Derivatives. XV. Electron Spin Resonance (E.S.R.) Spectra of Dibenzo-p-dioxin-2,7-dicarboxylic Acid and 2,7-Disulfonic Acid. Chem. Pharm. Bull. 12, 212 (1964).

972. Umemoto, Kisaburo, Deguchi, Yasuo, and Fujinaga, Taitiro. Electron Spin Resonance (E.S.R.) Spectra of Nitrophenol Anion Radicals. Bull. Chem. Soc. Japan 36, 1539 (1963).

973. Umemoto, Kisaburo, Deguchi, Yasuo, and Takaki, Hideo. Electron Spin Resonance (E.S.R.) Hyperfine Spectra of Di-p-Anisyl Nitric Oxide. Ibid., 560 (1963).

974. Ursu, I., Bodu, A., and Popescu, D. Isotopic Exchange Mechanism. Electron Spin Resonance (E.S.R.) Investigations of the Platinum-Carbon System. Acad. Rep. Populare Romine, Inst. Fiz. At. IS-21 (1963).

975. van Gerven, L., van Itterbeck, A., and de Lact, L. Low-Field Electron Paramagnetic Resonance Measurements in DPPH at Low Temperature. Paramagnetic Resonance, Proc. Intern. Conf., 1st, Jersusalem 2, 905 (1962).

976. Vichutinskii, A. A., Prokof'ev, A. I., and Shabalkin, V. A. Use of Electron Paramagnetic Resonance for the Study of Free Radicals Formed in Thermal Decomposition of  $\alpha, \alpha'$ -Azobis(isobutyronitrile). Zh. Fiz. Khim. 38, 983 (1964).

977. Vincow, Gershon. Electron Spin Resonance (E.S.R.) of the Thioxanthone S,S-dioxide Mononegative Ion. Conjugation in Sulphones. J. Chem. Phys. 37, 2484 (1962).

978. Vincow, Gershon, and Johnson, Philip M. Second Moments of Electron Spin Resonance (E.S.R.) Proton Hyperfine Spectra. Ibid. 39, 1143 (1963).

979. Viscrian, Ion, Tibu, Margareta, and Petrescu, Gabriela. Electron Paramagnetic Resonance of DPPH in Weak Magnetic Field. Absolute Measurement of a Magnetic Field Given by a Pair of Helmholtz Coils. Acad. Rep. Populară Române, Filiala Iași, Studii Cercetări Stiint., Fiz. Stiințe Tehnice 14, 381 (1963).

980. Vishnevskaya, G. P., Kozyrev, B. M., and Tishkov, P. G. Paramagnetic Relaxation in Concentrated Aqueous Solutions of  $(VO)^{2+}$ . Dokl. Akad. Nauk SSSR 152, 644 (1963).

981. Votinov, M. P., and Demidenko, N. I. Some Peculiarities of Electron Paramagnetic Resonance (E.P.R.) Spectra in Ferroelectric Ceramics With Ti and Their Explanation. Fiz. Tverd. Tela 4, 321 (1962).

982. Votinov, M. P., and Demidenko, N. I. Temperature Variation of the Width of the Electron Paramagnetic Resonance (E.P.R.) Spectrum in  $Ti-O_x$  System ( $x = 1.5 - 2.0$ ). Ibid., 3277 (1962).

983. Wasserman, E., Barash, L., Trozzolo, A. M., Murray, R. W., and Yager, W. A. Electron Spin Resonance of Triplet Cyclopentadienylidene and Idenylidene. J. Am. Chem. Soc. 86, 2304 (1964).

984. Wasserman, E., Snyder, L. C., and Yager, W. A. Electron Spin Resonance (E.S.R.) of the Triplet States of Randomly Oriented Molecules. J. Chem. Phys. 41, 1763 (1964).

985. Wasserman E., Trozzolo, A. M., Yager, W. A., and Murray, R. W. Electron Spin Resonance (E.S.R.) Hyperfine of Randomly Oriented Triplets: Structure of Substituted Methylenes. Ibid. 40, 2408 (1964).

986. Watkins, G. D. An Electron Paramagnetic Resonance (E.P.R.) Study of the Lattice Vacancy in Silicon. J. Phys. Soc. Japan 18, Suppl. 2, 22 (1963).

987. Wayne, R. C., and Cotts, R. M. E.S.R. (Electron Spin Resonance) Measurement of Spin Susceptibility of Graphite in a Low Magnetic Field. *J. Chem. Phys.* 39, 1337 (1963).
988. Weber, G. Electron Resonance of Transition Metal Complexes. *Arch. Sci.* 14, 102 (1961).
989. Weil, John A. Electron Spin Resonance of Stable Organic Free Radicals. The Dissociation of Hexaphenylethane. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 72-1-72-3 (1961).
990. Whiffen, D. H. Characteristic Hydrogen Hyperfine Couplings in Aliphatic Free Radicals. *Pure Appl. Chem.* 4, 185 (1962).
991. Whiffen, D. H. Electron Spin Resonance in Orientated Radicals. Proc. Colloq. Spectros. Intern., 10th, Univ. Maryland, 719 (1963).
992. Wilmhurst, T. H. Use of Long Cavities for Aqueous Samples in an Electron Spin Resonance Spectrometer. *Nature* 199, 477 (1963).
993. Windle, J. J., and Wiersema, A. K. Electron Paramagnetic Resonance (E.P.R.) of Naturally Abundant N<sup>15</sup> and S<sup>33</sup> in Peroxylamine Disulfonate Ion [NO(SO<sub>3</sub>)<sub>2</sub>]<sup>++</sup>. *J. Chem. Phys.* 39, 1139 (1963).
994. Yodzis, P. O., and Koski, W. S. g-Tensor Anisotropy in Polycrystalline Diphenyl Picryl Hydrazyl. *Ibid.* 38, 2313 (1963).
995. Zanchetta, Jean, Marchand, Andre, and Pacault, Adolphe. α,α-Diphenyl-β-picrylhydrazyl (DPPH) as a Standard for Electron Paramagnetic Resonance (E.P.R.). *Compt. Rend.* 258, 1496 (1964).
996. Zanchetta, J., Marchand, A., and Pacault, A. Technique of Study of Free Radicals in Pregraphitic Carbons: Choice of a Standard in Electron Paramagnetic Resonance (E.P.R.) Conditioning of Powdered Samples. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 76-1-76-7 (1961).
997. Zandstra, P. J., and Michaelsen, J. D. Electron Spin Resonance (E.S.R.) of Some Arylsulfenyl Radicals. *J. Chem. Phys.* 39, 933 (1963).

998. Zhidomirov, G. M., and Tavetkov, Yu. D. Possibility of Studying Free-Radical Conformation in Some Alicyclic Compounds by Means of Electron Paramagnetic Resonance (E.P.R.). Optika i Spektroskopiya 17, 67 (1964).

999. Lebedev, Ya. S., and Tavetkov, Yu. D. The Line Shape of the Electron Paramagnetic Resonance (E.P.R.) Spectra of Peroxide-Type Radicals in Oriented Polymers. Zh. Strukt. Khim. 3, 541 (1962).

1000. Tavetkov, Yu. D., and Lebedev, Ya. S. Study of Internal Motion in Polyisobutylene by Electron Paramagnetic Resonance (E.P.R.) Spectroscopy. Ibid. 2, 696 (1961).

#### SPECTROSCOPY.

1001. Adams, G. E., and Boag, J. W. Spectroscopic Studies of Reactions of the OH Radical. Proc. Chem. Soc., 112 (1964).

1002. Batley, M., and Lyons, L. E. Electron Affinities of Organic Molecules. Nature 196, 573 (1962).

1003. Baudet, Jeanne, and Berthier, Gaston. Incomplete Electronic Configurations. III. The First Energy Levels of the Benzyl Radical. J. Chim. Phys. 60, 1161 (1963).

1004. Becker, K. H., and Welge, K. H. Fluorescence of NH Radicals During the Photodissociation of NH<sub>3</sub> in the Vacuum Ultraviolet. Z. Naturforsch. 18a, 600 (1963).

1005. Bernal, Ivan, and Rieger, Philip H. Solvent Effects on the Optical and Electron Spin Resonance (E.S.R.) Spectra of Vanadyl Acetylacetone. Inorg. Chem. 2, 256 (1963).

1006. Bertheuil, Colette. Theoretical Study of Electronic Transitions in the Benzyl Radical and in Its Positive Ion. Compt. Rend. 256, 5097 (1963).

1007. Bindley, T. F., Watts, A. T., and Walker, S. Absorption and Emission Spectra of Aromatic Radicals. II. Electronic Absorption Spectra of Radicals Obtained on Photolysis of Dialkylbenzenes. J. Chem. Soc., 4327 (1962).

1008. Bindley, T. F., Watts, A. T., and Walker, S. Electronic Emission Spectra of Radicals From Fluorotoluenes. *Trans. Faraday Soc.*, 60, 1 (1964).
1009. Brewer, Richard G., and Kester, Frank L. Dissociation Energy of the CH Radical. *J. Chem. Phys.*, 40, 812 (1964).
1010. Buschow, K. H. J., and Velthorst, N. H. Adsorption Spectrum of Phenanthrene Dinegative Ion. *Z. Physik. Chem.*, 41, 45 (1964).
1011. Chantry, G. W. Optical Absorption Spectra of Oriented Free Radicals. *Spectry. Rept. Conf. Organ Hydrocarbon Res. Group Inst. Petrol.*, London, 149 (1962).
1012. Daehne, S., and Lenpold, D. Anomalous Bathochromy of Wurster Dyes. *Z. Naturforsch.*, 18a, 881 (1963).
1013. Dimroth, K., and Berndt, A. Structure of the Dimer of 2,4,6-Triphenylphenoxy. *Angew. Chem.*, 76, 434 (1964).
1014. Dixon, R. N. Free Radical Spectroscopy. *Spectry. Rept. Conf. Organ. Hydrocarbon Res. Group Inst. Petrol.*, London, 127 (1962).
1015. Dixon, R. N., and Kroto, H. W. Spectrum of the CBr Radical. *Trans. Faraday Soc.*, 59, 1484 (1963).
1016. Dixon, R. N., and Mason, B. F. Luminescence From the H-O<sub>2</sub> Reaction. *Nature*, 197, 1198 (1963).
1017. Dedonova, N. Ya., and Terenin, A. N. Excitation of Free Radicals in the Splitting of Polyatomic Molecules by Photons in Vacuo in the Ultraviolet Region. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, 27, 1094 (1963).
1018. Dudley, Francis B., and Cady, George H. The Equilibrium Between Peroxydisulfuryl Difluoride and Fluorosulfate Free Radicals. *J. Am. Chem. Soc.*, 85, 5375 (1963).
1019. Eloranta, Jorma. Substituent Effects in the Formation of Free-Radical Ions. II. Absorption Spectra of Free-Radical Ions Produced From  $\alpha$ -Bromo-naphthalene in Tetrahydrofuran. *Suomen Kemistilehti Sec. B*, 36, 171 (1963).

1020. Foster, R. Complete Electron Transfer in Organic Intermolecular Charge-Transfer Complexes. Photoelec. Spectrometry Group Bull. No. 15, 413 (1963).
1021. Friedrich, Hans Joachim. Influence of the Steric Effect on Infrared Absorption in Cyanines. Z. Naturforsch. 18b, 635 (1963).
1022. Garst, John F., Walmsley, Donald, Hewitt, Carol, Richards, William R., and Zabolotny, Ernest R. The Solvent Effect on the Electronic Spectra of Ion Pairs. Ketyle in Ethers. J. Am. Chem. Soc. 86, 412 (1964).
1023. Gerson, F. Electron Spin Resonance Spectra of the 1,3,6,8-Tetraazapryrene Radical Ions. Helv. Chim. Acta 47, 1484 (1964).
1024. Gordon, S., Hart, E. J., and Thomas, J. K. The Ultraviolet Spectra of Transients Produced in the Radiolysis of Aqueous Solutions. J. Phys. Chem. 68, 1262 (1964).
1025. Herzberg, G. Recent Work on Spectra of Free Radicals. ICSU Rev. 4, 179 (1962).
1026. Herzberg, G., and Verma, R. D. Spectra and Structures of the Free HSiCl and HSiBr Radicals. Can. J. Phys. 42, 395 (1964).
1027. Herzberg, G., and Warsop, P. A. Spectrum and Structure of the Free HNCN Radical. Ibid. 41, 286 (1963).
1028. Hirota, Noboru, and Weissman, S. I. Electronic Interaction in Ketyl Radicals. J. Am. Chem. Soc. 86, 2538 (1964).
1029. Hirst, D. M., and Linnett, J. W. The Allyl Radical and Anion. J. Chem. Soc., 1068 (1963).
1030. Hobey, W. D. Spin Densities in Hydrocarbon Ions With Degenerate Ground States. Mol. Phys. 7, 325 (1963-1964).
1031. Jacox, Marilyn E., and Milligan, Dolphus E. Low-Temperature Infrared Studies of the Chemistry of Free Radicals. Appl. Opt. 3, 873 (1964).

1032. Jackobi, H., Martin, H., and Kuhn, Hans. Light Absorption by the Radical-Cation of N,N,N',N'-Tetramethylbenzidine. *Sitzber. Ges. Befoerder. Ges. Naturw.* Marburg 83/84, 497 (1961-1962).

1033. Jordan, Peter C. Lower Electronic Levels of the Radicals PH and PH<sub>2</sub>. *J. Chem. Phys.* 41, 1442 (1964).

1034. Karpukhin, O. N., Shlyapintokh, V. Ya., Zolotova, N. V., Kozlova, Z. G., and Rusina, I. F. Mechanism for the Weakening of Chemiluminescence by Inhibitors of Free-Radical Reactions. *Zh. Fiz. Khim.* 37, 1636 (1963).

1035. Kawamori, Asako, and Suzuki, Keisuke. Proton Magnetic Resonance (P.M.R.) of Wuerster's Blue Perchlorate. *Mol. Phys.* 6, 95 (1964).

1036. Kemula, W., and Sioda, R. Spectra of Free Radical Anions of Some Aromatic Nitro Compounds. *Bull. Acad. Polon. Sci., Ser. Sci. Chim.* 11, 403 (1963).

1037. Kemula, Wiktor, and Sioda, Roman. Visible Spectra of the Free-Radical Anions of  $\alpha$ - and  $\beta$ -Nitronaphthalenes in Dimethylformamide. *Naturwissenschaften* 50, 708 (1963).

1038. Koenig, E., Schlaefer, H. L., and Herzog, S. Methods of Absorption and Reflection Spectroscopy of Extremely Oxygen-Sensitive Compounds. *Z. Chem.* 4, 95 (1964).

1039. Leach, Sydney. Luminescence Spectra of Some Trapped Organic Radicals. *Luminescence Org. Inorg. Mater., Intern. Conf.* New York, 176 (1961).

1040. McGrath, W. D., and McGarvey, J. J. Ultraviolet Absorption Spectrum of the CH<sub>3</sub>O Radical. *Nature* 201, 991 (1964).

1041. McGrath, W. D., and Morrow, T. Ultraviolet Absorption Spectrum of the Free Fulminate (C-N-O) Radical. *Ibid.* 203, 619 (1964).

1042. Milligan, Dolphus E. Infrared Spectroscopic Study of Intermediates in the Photolysis of Several Azides. *Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala*, 45-1-26 (1961).

1043. Morehead, F. F., and Title, R. S. Correlation of Electron Paramagnetic Resonance (E.P.R.) and Electro-Optical Measurements in ZnS. *J. Phys. Chem. Solids* 24, 719 (1963).

1044. Nakahara, Akitsugu, and Wang, Jui H. Charge-Transfer Complexes of Methylviologen. *J. Phys. Chem.* 67, 496 (1963).

1045. Pannetier, Guy, Goudmand, Pierre, Dessaix, Odile, and Guenebaut, Henri. Pyrolysis of N<sub>3</sub>H and N<sub>3</sub>D in Shock Waves. Two New Bands From an ND Radical. *Compt. Rend.* 256, 3082 (1963).

1046. Peyron, M. Atoms and Free Radicals Spectroscopy. NASA Doc. N62-14611 (1962).

1047. Peyron, Maurice. Spectroscopic Studies of Free Radicals Produced in Reactions Involving Atomic H. *Proc. Intern. Symp. Mol. Struct. Spectry.*, Tokyo (1962).

1048. Polanyi, J. C. Chemical Reaction as a Spectroscopic Source. *Colloq. Spectros. Intern.*, 8th, Lucerne, Switz., 127 (1959).

1049. Porter, George, and Land, Edward J. Benzyl, Anilino, Phenoxy, and Related Free Radicals. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, B4-1-6 (1961).

1050. Ramsey, D. A. Optical Spectra of Gaseous Free Radicals. *Proc. Colloq. Spectros. Intern.*, 10th, Univ. Maryland, 583 (1962).

1051. Sugden, T. M. Spectrophotometry of Free Radicals in Flames. *Spectry.*, Rept. Conf. Orgar. Hydrocarbon Res. Group Inst. Petrol., London, 137 (1062).

1052. Thrush, B. A., and Zwolenik, J. J. Absorption Spectrum of the Tropyl (Cycloheptatrienyl) Radical. *Proc. Chem. Soc.*, 339 (1962).

1053. Vasil'ev, R. F., Vichutinskii, A. A., and Cherkasov, A. S. Chemiluminescence Activated by Anthracene Derivatives. *Dokl. Akad. Nauk SSSR* 149, 124 (1963).

1054. Watts, A. T., and Walker, S. Absorption and Emission Spectra of Aromatic Radicals. I. Absorption and Emission Spectrum of the Benzyl Radical in the Visible Region. *J. Chem. Soc.*, 4323 (1962).

1055. Weissman, S. J. Relation Between Absorption and Fluorescence Spectra of Triphenylmethyl. *J. Chem. Phys.* 37, 1886 (1962).

1056. Wieland, K. Spectra of Gas-Forming Radicals in Thermal Equilibrium. *Proc. Intern. Meeting Mol. Spectry.*, 4th, Bologna 2, 592 (1959).

1057. Woszczyk, A. Spectrum of the NH<sub>2</sub> Radical; Its Application to Cometary Spectra. *Mem. Soc. Roy. Sci. Liege, Collection in -4°.* 2, 113 (1962).

1058. Zakharov, I. V., and Shiyapintokh, V. Ya. Chemiluminescence in Slow Chemical Reactions. I. Chemiluminescence Regularities in Catalyzed Ethylbenzene Oxidation. *Kinetika i Kataliz* 4, 239 (1963).

#### PHOTOLYSIS.

1059. Adams, G. E., Baxendale, J. H., and Boag, J. W. Electron Attachment in Irradiated Solutions. *Proc. Roy. Soc. Ser. A* 277, 549 (1964).

1060. Akhtar, M., Barton, D. H. R., and Sammes, P. G. Radical Exchange During Nitrite Photolysis. *J. Am. Chem. Soc.* 86, 3394 (1964).

1061. Amrich, Michael J., and Bell, Jerry A. Photoisomerization of Diazirine. *Ibid.*, 292 (1964).

1062. Angelescu, E., and Cornea, F. Kinetic Study of the Oxidation-Reduction of Certain Thiourea Derivatives With Methylene Blue. *Analele Univ. "C. I. Parhen", Ser. Stiint. Nat.* 10, No. 30, 111 (1961).

1063. Atkins, P. W., Symons, M. C. R., and Trevalion, P. A. Evidence for Pairwise Trapping of Photolytic Free Radicals. *Proc. Chem. Soc.*, 222 (1963).

1064. Ayscough, P. B., and Sargent, F. P. Photolytic Generation of Aromatic Radical Anions. Electron Spin Resonance Studies. *Ibid.*, 94 (1963).

1065. Ayscough, P. B., Cocker, A. J., Dainton, F. S., Hirst, S., and Weston, M. Excited Chloroethyl Radicals. *Ibid.*, 244 (1961).

1066. Azizova, O. A. Peculiarities of Electron Paramagnetic Resonance (E.P.R.) Spectra of Amino Acids and Proteins Induced by Ultra-violet Light. *Biofizika* 8, 556 (1963).

1067. Back, R. A. Combination Reactions of Imino Radicals in the Flash Photolysis of Isocyanic Acid. *J. Chem. Phys.* 40, 3493 (1964).

1068. Bagdasar'yan, Kh. S., Muromtsev, V. I., and Sinitsyna, Z. A. Two-Quantum Photochemical Reaction. The Photolysis of a Frozen Solution of Diphenylamine in Ethanol. *Dokl. Akad. Nauk SSSR* 152, 349 (1963).

1069. Bagdasar'yan, Kh. S., Sinitsyna, Z. A., and Muromtsev, V. I. Two-Quantum Photochemistry. Demonstration That Molecules in the Second Triplet State Participate in a Reaction. *Ibid.* 153, 374 (1963).

1070. Balzani, Vincenzo, Carassiti, Vittorio, and Loos, Ramon Soto. Photochemistry of Complex Salts in Solution. IX. Substitution Reactions in the Systems  $\text{Fe}(\text{CN})_6^{4-}$ -Dipyridine-Light and  $\text{Fe}(\text{CN})_6^{1-}$ -Phenanthroline-Light. *Ann. Chim.* 54, 103 (1964).

1071. Balzani, Vincenzo, Carassiti, Vittorio, and Moggi, Luca. Photochemistry of Complex Salts in Solution. X. Photochemical Reactions of the Complexes  $\text{K}_2\text{Fe}(\text{CN})_4$ (bipyridyl) and  $\text{K}_2\text{Fe}(\text{CN})_4$ (o-phenanthroline). *Ibid.*, 251 (1964).

1072. Baranov, E. V., Kholmogorov, V. E., and Terenin, A. N. Light-Induced Electron Spin Resonance (E.P.R.) Signals in  $\text{ZnO}$ . *Dokl. Akad. Nauk SSSR* 146, 125 (1962).

1073. Beckett, A., and Porter, G. Primary Photochemical Processes in Aromatic Molecules. IX. Photochemistry of Benzophenone in Solution. *Trans. Faraday Soc.* 59, Pt. 9, 2038 (1963).

1074. Beckett, A., and Porter, G. Primary Photochemical Processes in Aromatic Molecules. X. Photochemistry of Substituted Benzophenones. *Ibid.*, 2051 (1963).

1075. Beckett, A., Osborne, A. D., and Porter, G. Primary Photochemical Processes in Aromatic Molecules. XI. Radicals and Radical Anions Derived From Benzaldehyde, Acetophenone, and Benzil. *Ibid.* 60, 873 (1964).

1076. Bellas, M. G., Wan, J. K. S., Allen, W. F., Strausz, O. P., and Gunning, H. E. The Reaction of  $Hg\ 6(^3P_1)$  Atoms With Vinyl Chloride. *J. Phys. Chem.* 68, 2170 (1964).
1077. Benderskii, V. A., Kogan, B. Ya., Abramov, Yu. Yu., and Kapranova, L. E. Sticking Levels in Organic Photoconductors. *Dokl. Akad. Nauk SSSR* 156, 897 (1964).
1078. Berman, Joseph D., Stanley, Jack H., Sherman, W. V., and Cohen, Saul G. Sensitization and Catalysis of Light-Induced Decarbonylation of Aldehydes. *J. Am. Chem. Soc.* 85, 4010 (1963).
1079. Birks, J. B., and Aladekomo, J. B. The Photodimerization and Excimer Fluorescence of 9-Methyl Anthracene. *Photochem. Photobiol.* 2, 415 (1963).
1080. Bogle, G. S., Burgess, V. R., Forbes, W. F., and Savige, W. E. Photolysis and Photooxidation of Aminoacids and Peptides. V. The Electron Spin Resonance (E.S.R.) Spectra of Irradiated Cystine and Related Compounds. *Ibid.* 1, 277 (1962).
1081. Bowen, E. J., and Eland, J. H. D. Photochemistry of Diphenylamine Solutions. *Proc. Chem. Soc.*, 202 (1963).
1082. Bowles, R., Majer, J. R., and Robb, J. C. Photo-decomposition of Halogenated Ketones. I. Gas-Phase Photolysis of 1,3-Dichlorotetrafluoroacetone. *Trans. Faraday Soc.* 58, 1541 (1962).
1083. Briegleb, G., Jung, W., and Herre, W. Anion and Solvent Dependence of an Interionic Electron Exchange in Ion Pairs in N-(2,6-dichlorobenzyl)quinoline Salts. *Z. Physik. Chem.* 38, 253 (1963).
1084. Bubnov, N. N., Bazhin, N. M., and Voevodskii, V. V. Formation of Alkyl Radicals as a Result of Photoinduced Transfer of an Electron. *Kinetika i Kataliz* 5, 568 (1964).
1085. Bukowski, J., and Drabent, R. Spectral Investigation on Rhodamine B in Sodium-Silicon (Water-Glass) Solutions. *Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys.* 11, 421 (1963).
1086. Burgess, Edward M., and Lavanish, J. M. Photochemical Decomposition of N-nitrosamines. *Tetrahedron Letters*, 1221 (1964).

1087. Carassiti, Vittorio, Condorelli, Giuseppe, and Costanzo, Lucia Laura. Photochemistry of Complex Salts in Solution. XI. Photochemistry of  $\text{Ag}(\text{dipyridyl})_2^{2+}$  at Short Wavelengths. *Ann. Chim.* 54, 303 (1964).
1088. Chirakadze, G. G., and Nanobashvili, E. M. The Photooxidation of Mercaptans. *Tr. Inet. Prikl. Khim. i Elektrokhim.*, Akad. Nauk Gruz. SSR 4, 69 (1963).
1089. Cho, B.-Y., Nelson, R. C., and Brown, L. C. Electron Spin Resonance (E.S.R.) Study of Some Organic Photoconductors. *J. Chem. Phys.* 39, 499 (1963).
1090. Choi, Sang-II, and Rice, Stuart A. Exciton-Exciton Interactions and Photoconductivity in Organic Crystals. *Phys. Rev. Letters* 8, 410 (1962).
1091. Chow, Yuan-Lang. Photolysis of N-nitrosamines. *Tetrahedron Letters*, 2333 (1964).
1092. Cochran, Edward L., and Adrian, Frank J. Electron Spin Resonance Studies of Radicals Formed by Secondary Processes in Photolytic Systems at 4.2°K. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 121 (1961).
1093. Cochran, Edward L., Adrian, Frank J., and Bowers, Vernon A. E.S.R. (Electron Spin Resonance) Study of Ethynyl and Vinyl Free Radicals. *J. Chem. Phys.* 40, 213 (1964).
1094. Cole, E. R. Interchange Reactions of Disulfides. *Nature* 198, 1083 (1963).
1095. Corvaja, Carlo, Giacometti, Giovanni, and Nordio, Pierluigi. Molecular Orbital Study of Proton Hyperfine Splitting Constants in  $\text{H}_2\text{CN}$  Radical. *Theoret. Chim. Acta* 1, 393 (1963).
1096. Coyle, D. J., Peterson, R. V., and Heicklen, Julian. The Photolysis and Pyrolysis of 4-Methyl-4-methoxy-2-pentanone. *J. Am. Chem. Soc.* 86, 3850 (1964).
1097. Currie, C. L., and Darwent, B. de B. The Photochemical Decomposition of Methyl Azide. *Can. J. Chem.* 41, 1552 (1963).
1098. Dauben, W. F. Photochemistry of Conjugated Dienes. *Chem. Week-Blad* 60, 381 (1964).

1099. Dava, M. P., and Schlessinger, R. H. Synthesis of a Phenanthridine From an Aromatic Schiff Base by a Photooxidative Ring Closure. *Tetrahedron Letters*, 2109 (1964).
1100. de Grott, M. S., and van der Waals, J. H. Paramagnetic Resonance in Phosphorescent Aromatic Hydrocarbons. III. Conformational Isomerism in Benzene and Triptycene. *Mol. Phys.* 6, 545 (1963).
1101. Delzenne, G., Toppet, S., and Smets, G. Photosensitized Polymerization of Acrylamide. *Bull. Soc. Chim. Belges* 71, 857 (1962).
1102. Dieleman, J. Paramagnetic Resonance of a Photosensitive Center in CdS:Cu, Ga. *Proc. Colloq. AMPERE* 11, 409 (1962).
1103. Dolan, E. E.S.R. (Electron Spin Resonance) Signals Observed in Ultraviolet-Irradiated Glasses of Organic Solutions. *J. Chem. Phys.* 37, 2508 (1962).
1104. Dolan, Edward. Electron Spin Resonance Signals and Stimulated Emission Observed in Photosensitized, Rigid Organic Glasses Containing Tetramethyl-p-phenylenediamine. Univ. Microfilms, Order No. 64-1024.
1105. Douzou, Pierre, and Ptak, Marius. Detection in Tryptophan of a Radical Configuration of Low Energy. *Compt. Rend.* 256, 516 (1963).
1106. Drabent, R., and Drabent, Z. Liquid and Solid Sodium-Silicon Solutions (Water Glass) as Solvents of Luminescent Dyes. *Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys.* 11, 415 (1963).
1107. Duchesne, Jules, and van de Vorst, Albert. Infrared Photoisomerization. *Compt. Rend.* 258, 4971 (1964).
1108. Duncan, F. J., and Trotman-Dickenson, A. F. The Reactions of Phenyl Radicals From the Photolysis of Acetophenone and the Strength of the C-H Bond in Benzene. *J. Chem. Soc.*, 4672 (1962).
1109. Elad, Dov, and Youssefych, Raymond D. Photochemical Conversion of Acetals to Carboxylic Esters. *Tetrahedron Letters*, 2189 (1963).

1110. El-Sayed, M. A. A New Class of Photochromic Substances: Metal Carbonyls. *J. Phys. Chem.* 68, 433 (1964).
1111. Ermolaev, V. L., and Sveshnikova, E. V. Inductive-Resonance Energy Transfer From Aromatic Molecules in the Triplet State. *Dokl. Akad. Nauk SSSR* 149, 1295 (1963).
1112. Ershov, B. G., and Pikaev, A. K. Electron Paramagnetic Resonance (E.P.R.) Spectra of the Free Radicals Formed in Photolysis of Frozen Alkaline Aqueous Solutions of Hydrogen Peroxide. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 922 (1964).
1113. Farren, J., Gilbert, J. R., Linnett, J. W., and Read, I. A. Effect of Deuterium Iodide and Hydrogen Bromide on the Photooxidation of Methyl Iodide. *Trans. Faraday Soc.* 60, 740 (1964).
1114. Fell, G. S., and Spence, J. B. Comparative Radical Reactivity of Polycyclic Aromatic Hydrocarbons. *Acta Unio Intern. Contra Cancrum* 19, 497 (1963).
1115. Ferrari, Giovanni, Passero, Calvino, and Pedrotti, Antonio. Photochemical Transformation of Aspartic Acid in Aqueous Solution. *Gazz. Chim. Ital.* 94, 223 (1964).
1116. Fischer L. C., and Mains, Gilbert J. The Temperature Dependence of the Flash Photolysis of Diethylketone. *J. Phys. Chem.* 68, 188 (1964).
1117. Fisher, I. P., and Tipper, C. F. H. Oxidation of Methane at About 400°. I. Reaction Catalyzed by the Photodecomposition of Acetone. *Trans. Faraday Soc.* 59, 1163 (1963).
1118. Fisher, I. P., and Tipper, C. F. H. Oxidation of Methane at About 400°. II. Role of Peroxides and the Reaction of Methyl Radicals and Oxygen. *Ibid.*, 1174 (1963).
1119. Foote, Christopher S., and Wexler, S. Singlet Oxygen. A Probable Intermediate in Photosensitized Autoxidations. *J. Am. Chem. Soc.* 86, 3880 (1964).
1120. Fox, John R., and Hammond, George S. Mechanisms of Photochemical Reactions in Solution. XXVI. Photosensitized Decomposition of Azo Compounds. *Ibid.*, 4031 (1964).

1121. Garofano, Torquato, and Santangelo, Mariano. Molecular Photolysis-Organic-Free Radicals Obtained by Ultraviolet Irradiation. *Ric. Sci. Rend. Ser. A* 4, 75 (1964).

1122. Getoff, Nikola. Synthesis of Organic Substances From Aqueous Solutions of Carbon Dioxide by Action of Ultraviolet Radiation in the Absence of Chlorophyll. *Oesterr. Chemiker-Ztg.* 63, 376 (1962).

1123. Ginsburg, V. A., Vlasova, E. S., Vasil'eva, N. M., Mirzabekova, N. S., Makarov, S. P., Shchekotikhin, A. I., and Yakubovich, A. Ya. Photoreaction of Hexafluoroazomethane With Unsaturated Compounds. *Dokl. Akad. Nauk SSSR* 149, 97 (1963).

1124. Goan, J. C., Huether, C. H., and Podall, H. E. Photochemical Reaction of Metal Carbonyls and 1,3-Diketones. *Inorg. Chem.* 2, 1078 (1963).

1125. Graham, D. M., Mieville, R. L., and Sivertz, C. Photoinitiated Reactions of Thiols and Olefins. I. The Thiyl-Radical-Catalyzed Isomerization of Burene-2 and 1,2-Ethylene-d<sub>2</sub>. *Can. J. Chem.* 42, 2239 (1964).

1126. Graham, D. M., Mieville, R. L., Pallen, R. H., and Sivertz, C. Photoinitiated Reactions of Thiols and Olefins. II. The Addition of Methanethiol to Unconjugated Olefins. *Ibid.*, 2250 (1964).

1127. Gritter, Roy J., and Sabatino, Edward C. Free-Radical Chemistry of Cyclic Ethers. VII. Ultraviolet Photolysis of Epoxides and Propylene Sulfide in the Liquid Phase. *J. Org. Chem.* 29, 1965 (1964).

1128. Grotewold, J., and Kerr, J. A. The Interactions of the Lower Alkyl Radicals. I. Methyl, Ethyl, and Propyl Radicals. *J. Chem. Soc.*, 4337 (1963).

1129. Grotewold, J., and Kerr, J. A. The Interactions of the Lower Alkyl Radicals. II. The Effect of the Radical Source on the Disproportionation-Combination Reactions of Methyl and Propyl Radicals. *Ibid.*, 4342 (1963).

1130. Haller, I., and Srinivasan, R. Photochemistry of 1,3-Butadiene. Details of the Primary Processes and Mechanism of Photopolymerization. *J. Chem. Phys.* 40, 1992 (1964).

1131. Hammond, George S., and Hardham, William M. Mechanisms of Photoreactions in Solution. XV. Photosensitized Addition of Maleic Anhydride to Benzene. *Proc. Chem. Soc.*, 63 (1963).
1132. Hautchloque, Simone. Photolysis of Bromotrichloromethane in the Gaseous Phase. *Compt. Rend.* 256, 2601 (1963).
1133. Havemann, R., Pietsch, H., and Wolf, S. Photogalvanic Effect of the Photochemical Systems Thionine/Ferrous Ions and Methylene Blue/Ascorbic Acid. *Z. Wiss. Phot., Photophysik Photochem.* 57, 88 (1963).
1134. Hayashi, Taro, and Maeda, Koko. Storage of Light Energy by a Solution of Photochromatic 1,1'-Bi[2,4,5-triphenylimidazyl] at Low Temperatures. *Bull. Chem. Soc. Japan* 36, 1052 (1963).
1135. Heicklen, Julian, Johnston, Harold S., and Newton, John. Photooxidation of the Simple Alkyl Iodides. *Bull. Soc. Chim. Belges* 71, 744 (1962).
1136. Holroyd, Richard A., and Klein, George W. Mercury Photosensitized Decomposition of Aliphatic Hydrocarbons-Radical Detection With Ethyl-Carbon-14 Radicals. *J. Phys. Chem.* 67, 2273 (1963).
1137. Hutton, Robert F., and Steel, Colin. Photoisomerization of Azomethane. *J. Am. Chem. Soc.* 86, 745 (1964).
1138. Ivanoff, N. Photochemical Reactions of Polynuclear Aromatic Compounds With Carbon Tetrachloride. *Bull. Soc. Chim. Belges* 71, 759 (1962).
1139. Jaffe, H. H., Beveridge, David L., and Jones, H. Lloyd. Excited State pK's. I. Azobenzene and Azoxybenzene. *J. Am. Chem. Soc.* 86, 2932 (1964).
1140. Jaffe, H. H., Jones, H. Lloyd, and Isaacs, M. Excited State pK's. II.  $\Delta \nu^{\star} \sigma$  Relations. *Ibid.*, 2934 (1964).
1141. Joebstl, J. Irradiation Studies on Alkali Azides. *Proc. Intern Microscopy Symp.*, 8th, Chicago, 30 (1960).
1142. Johnson, Calvin Keith. Free Radical Reactions of Some  $\alpha, \beta$ -Epoxy Ketones. Configurations and Rearrangements of the Diastereoisomeric Pulegone Oxides. Photochemical Rearrangements of Some  $\alpha, \beta$ -Epoxy Ketones. Univ. Microfilms, Order No. 64-4975.

1143. Johnson, G. S., Jr., and Gutowsky, H. S. High-Resolution E.S.R. (Electron Spin Resonance) Spectra of Photochemically Generated Free Radicals: The Viologens. *J. Chem. Phys.* 39, 58 (1963).

1144. Johnson, H. W., Jr., Pitts, J. N., Jr., and Burleigh, M. Possible Formation of Crossed Pinacols in the Photolysis of Benzophenone Mixtures. *Chem. Ind.*, 1493 (1964).

1145. Jortner, Joshua, Choi, Sang-II, Katz, Joseph L., and Rice, Stuart A. Triplet Energy Transfer and Triplet-Triplet Interaction in Aromatic Crystals. *Phys. Rev. Letters* 11, 323 (1963).

1146. Kato, Shunji, Morita, Masaharu, and Koizumi, Masao. Transient Intermediates in the Photoreduction of Methylene Blue. *Bull. Chem. Soc. Japan* 37, 117 (1964).

1147. Kellmann, A. Photochemical Reactions of Acridine in Hydrogen-Containing Solvents. *Bull. Soc. Chim. Belges* 71, 811 (1962).

1148. Kemula, W., and Grabowska, A. Reactivity of Aromatic Hydrocarbons in the Excited Triplet State. II. Investigation of the Photochemical Reaction of Benzene With Nitric Oxide. *Bull. Acad. Polon. Sci., Ser. Sci. Chim.* 8, 517 (1960).

1149. Kholmogorov, V. E., and Terenin, A. N. Crystalline Pigments and Dyes. *Naturwiss.* 50, 299 (1963).

1150. Kholmogorov, V. E., and Terenin, A. N. Light-Induced Signals of Electron Spin Resonance (E.S.R.) in Organic Dye Crystals. *Dokl. Akad. Nauk SSSR* 146, 652 (1962).

1151. Kholmogorov, V. E., Baranov, E. V., and Terenin, A. N. Investigation by the Electron Paramagnetic Resonance Method of the Sensitization of Dehydrogenation of Alcohols at 77°K. *Ibid.* 149, 142 (1963).

1152. Kholmogorov, V. E., Baranov, E. V., and Terenin, A. N. Role of the Triplet State of Aromatic Amines in the Photodehydration of Alcohols at 77°K. *Ibid.* 152, 1399 (1963).

1153. Koizumi, Masao, Obata, Hiroshi, and Hayashi, Shigenari. Photoreduction of Thiazine Dyes in Aqueous Solutions. *Bull. Chem. Soc. Japan* 37, 108 (1964).

1154. Kozlov, Yu I., Muromtsev, V. I., Piskunov, A. K., Shigorin, D. N., Ozerova, G. A., and Verein, N. V. The Formation of Radicals Via the Triplet State by Ultraviolet (UV) Irradiation of Frozen Solutions of Aromatic Molecules. *Zh. Fiz. Khim.* 37, 2800 (1963).
1155. Kuwata, Keiji, Ichikawa, Takahisa, and Hirota, Kozo. Electron Spin Resonance (E.S.R.) Study on the Ultraviolet Irradiation Effect of High-Polyol Hydrogen Peroxide Systems. *Nippon Kagaku Zasshi* 83, 652 (1962).
1156. Lagercrantz, Carl, and Yhland, Margareta. Interpretation of the Electron Spin Resonance (E.P.R.) Spectrum of the Light-Induced Radicals From *s*-Trinitrobenzene Dissolved in Tetrahydrofuran. *Acta Chem. Scand.* 16, 1799 (1962).
1157. Lagercrantz, Carl, and Yhland, Margareta. Light-Induced Free Radicals in Solutions of Some Unsaturated Compounds and Tetrannitromethane. *Ibid.*, 1807 (1962).
1158. Lagercrantz, Carl, and Yhland, Margareta. Photo-Induced Free-Radical Reactions in the Solutions of Some Tars and Humic Acids. *Ibid.* 17, 1299 (1963).
1159. Land, E. J., and Porter, G. Primary Photochemical Processes in Aromatic Molecules. VII. Spectra and Kinetics of Some Phenoxy Derivatives. *Trans. Faraday Soc.* 59, Pt. 9, 2016 (1963).
1160. Land, E. J., and Porter, G. Primary Photochemical Processes in Aromatic Molecules. VIII. Absorption Spectra and Acidity Constants of Anilino Radicals. *Ibid.*, 2027 (1963).
1161. Leach, Sydney, and Grajear, Lydie. The Photolysis of Toluene, Dibenzyl, and Benzyl Chloride in Rigid Media: Studies by Absorption and Luminescence Spectroscopy. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 36, 1 (1961).
1162. Leermakers, Peter A., and Vesley, George F. Organic Photochemistry and the Excited State. *J. Chem. Educ.* 41, 535 (1964).
1163. Leermakers, Peter A., and Vesley, George F. Photolysis of Pyruvic Acid in Solution. *J. Org. Chem.* 28, 1160 (1963).

1164. Linschitz, Henry, and Grellman, Karl Heinz. Reaction Pathways in the Photochemical Conversion of Diphenylamines to Carbazoles. *J. Am. Chem. Soc.* 86, 303 (1964).
1165. LuValle, James E. Chemical and Spectral Sensitization of the Silver Halides: Exciton Mechanisms in Latent Image Formation; Exciton-Exciton Interaction Mechanisms in Spectral Sensitization. *Phot. Sci. Eng.* 8, 229 (1964).
1166. LuValle, James E., Leifer, Asa, Dougherty, P. H., and Korsl, M. Spectral Sensitization. I. Some Properties of Sensitizing and Desensitizing Dyes. *J. Phys. Chem.* 66, 2403 (1962).
1167. McDowell, C. A., and Sifniades, S. Isomerization as a Primary Process in the Photolysis of Croton-Aldehyde. *J. Am. Chem. Soc.* 84, 4606 (1962).
1168. Mains, Gilbert J. A Search for Hot Radical Reactions in Flash Photolysis. US Dept. Com., Office Tech. Serv., AD 429,260, 54 pp., 1963.
1169. Majer, J. R., Capey, W. D., and Robb, J. C. Isotope Effect in Radical Reactions. *Nature* 203, 294 (1964).
1170. Mason, J. Perfluoroalkyl Compounds of Nitrogen. V. The Dimer (N-nitritoamine) of Trifluoronitrosomethane. *J. Chem. Soc.*, 4531 (1963).
1171. Mason, J. Perfluoroalkyl Compounds of Nitrogen. VI. The Photolysis of Trifluoronitrosomethane. *Ibid.*, 4537 (1963).
1172. Massey, A. G., and Zwoleinik, J. J. Flash Photolysis of Boron Chlorides. *Ibid.*, 5354 (1963).
1173. Matthews, Clifford N., Driscoll, John S., Harris, John E., and Wineman, Robert J. Photochromism in Mesomeric Phosphonium Salts. *J. Am. Chem. Soc.* 86, No 22, 4349 (1962).
1174. Mauser, H. The Kinetics of Complicated Photochemical Reactions. *Z. Naturforsch.* 19a, 767 (1964).
1175. Mauser, Heinz, and Heitzer, Helmut. The Photoreduction of Benzophenone. *Naturwissenschaften* 50, 568 (1963).

1176. Mitra, R. P., Jain, D. V. S., Bannerjee, A. K.. and Raghavachari, K. V. Role of Free Radicals in the Photooxidation of  $\text{Fe}^{2+}$  in Acidic Solutions of Ferrocyanide. *Nature* 200, 163 (1963).

1177. Morton, J. R., and Falconer, W. E. Electron Paramagnetic Resonance (E.P.R.) Spectrum of the Acetyl Radical. *Ibid.* 197, 1103 (1963).

1178. Murgulescu, I. G., and Simon, Z. Photochemical Reactions and Nonradiant Transitions in Ketones and Aldehydes. *Acad. Rep. Populare Romine, Studii Cercetari Chim.* 11, 161 (1963).

1179. Niizuma, Shigeya, and Koizumi, Masao. The Photo-reduction of Acridine in Deaerated and Aerated Alcohol Solutions. II. *Bull. Chem. Soc. Japan* 36, 1629 (1963).

1180. Odaira, Y., Tominaga, T., Sugihara, T., and Tsutsumi, S. Direct Introduction of Ethyl Oxalyl Radical Into Cyclohexane by photochemical Reaction. *Tetrahedron Letters*, 2527 (1964).

1181. Ohnishi, Shunichi, Sugimoto, Shunichi, and Nitta, Isamu. Photoinduced Change of Organic Free Radicals as Studied by Electron Spin Resonance (E.S.R.). I. Conversion of Allyl-Type to Alkyl-Type Radicals in Irradiated Polyethylene. *J. Chem. Phys.*, 2647 (1963).

1182. Osugi, Jiro, Sato, Masanori, and Sasaki, Muneo. Kinetic Studies of Free Radicals Reactions. I. Reaction of Diphenylpicrylhydrazyl With Free Radicals Formed by the Photolysis of Azo-bis(isobutyronitrile). *Rev. Phys. Chem. Japan* 33, 53 (1963).

1183. Ottolenghi, Michael. Electron Ejection and Fluorescence in Aqueous  $\beta$ -Naphthol Solutions. *J. Am. Chem. Soc.* 85, 3557 (1963).

1184. Overger, C. G., and Ansclme, Jean Pierre. The Thermal and the Photolytic Decomposition of 1-Phenyldiazoethane. *J. Org. Chem.* 29, 1188 (1964).

1185. Owen, G. E., Jr., Pearson, J. M., and Szwarc, M. Activation Energies and Entropies of Activation of  $\text{CF}_3$  Radical Addition. II. Comparison of Liquid and Gaseous Reactions. *Trans. Faraday Soc.* 60, 564 (1964).

1186. Pac, Chyongjin, and Tsutsumi, Shigeru. Direct Introduction of the Ethoxycarbonyl Radical Into Hydrocarbons by Photochemical Reactions. Bull. Chem. Soc. Japan 36, 234 (1963).
1187. Padday, J. F. Adsorption of Cyanine Dyes at Silver Halide Surface. Trans. Faraday Soc. 60, 1325 (1964).
1188. Padnos, Norman, and W. Noyes, Albert, Jr. Photolysis of Biacetyl-Oxygen Mixtures at 4358 Å. J. Phys. Chem. 68, 464 (1964).
1189. Pearson, J. M., and Szwarc, M. Activation Energies and Entropies of Activation of  $\text{CF}_3$  Radical Addition. I. Gas Phase. Trans. Faraday Soc. 60, 553 (1964).
1190. Piffault, C., Duhamel, J., Laulan, J., Roques, J. C., and Caroff, J. The Lazarev Reaction. Investigation of the Influence of Dilution in Photochemistry. J. Radiol., Electrol. Med. Nucl. 42, 74 (1961).
1191. Piskunov, A. K., Nurmukhametov, R. N., Shigorin, D. N., Muromtsev, V. I., and Ozerova, G. A. Investigation of Photo-excited Triplet States of Polyatomic Molecules by the Electron Paramagnetic Resonance (E.P.R.) Method and by Means of Phosphorescence. Izv. Akad. Nauk SSSR, Ser. Fiz. 27, 634 (1963).
1192. Pitts, James N., Jr., Kuwana, Theodore, and Marchetti, A. Photochemical and Electrochemical Studies of Organic Free Radicals. I. Photopotentials in  $\gamma$ -Ray-Alcohol Systems. Preprints Papers Intern. Symp. Free Radicals, '61, Uppsala, 51-1-13 (1961).
1193. Pitts, J. N., Jr., Schuck, E. A., and Wan, J. K. S. Photoreduction of 2,2-Diphenyl-1-picrylhydrazyl (DPPH) in Hydrocarbons. Ibid., 296 (1964).
1194. Pitts, J. N., Jr., Wan, J. K. S., and Schuck, E. A. Photochemical Studies in an Alkali Halide Matrix. I. An o-Nitrobenz-aldehyde Actinometer and Its Application to a Kinetic Study of the Photo-reduction of Benzophenone by Benzhydrol in a Pressed Potassium Bromide Disk. J. Am. Chem. Soc. 86, 3606 (1964).
1195. Postnikov, L. M., and Shlyapintokh, V. Ya. Mechanism of Formation of Excited Formaldehyde Molecules in Oxidation Reactions. Dokl. Akad. Nauk SSSR 150, 340 (1963).

1196. Price, W. C., Bralsford, R., and Roessler, D. M. Vacuum Ultraviolet Spectra and Photoionization of Molecules and Radicals. Spectry., Rept. Conf. Organ. Hydrocarbon Res. Group Inst. Petrol., London, 279 (1962).

1197. Ptak, Marius, and Douzou, Pierre. Electron Paramagnetic Resonance (E.P.R.) Study of the Triplet State of Aromatic Amino Acids. Compt. Rend. 257, 438 (1963).

1198. Ptak, Marius, and Douzou, Pierre. Examination of Optically Excited Amino Acids by Electron Spin Resonance at Very Low Temperature. Nature 199, 1092 (1963).

1199. Rebbert, R. E., and Ausloos, P. Photochemical Decomposition of Organic Compounds in the Solid State. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 3-1-4 (1961).

1200. Roquette, B. C., and Wijnen, M. H. J. The Photolysis of Carbon Tetrachloride in the Presence of Ethane and Ethylene. J. Am. Chem. Soc. 85, 2053 (1963).

1201. Russell, Glen A., and Geels, Edwin J. Generation of Aromatic Radical-Anions by Photoreduction and Electron Transfer Processes. Tetrahedron Letters, 1333 (1963).

1202. Russell, Glen A., and Ito, Akihiko. Photochlorination of Bromocyclopentane and Chlorocyclopentane. J. Am. Chem. Soc. 85, 2983 (1963).

1203. Russell, Glen A., Ito, Akihiko, and Konaka, R. Photochlorination of Chlorocyclohexane and Bromocyclohexane. Ibid., 2988 (1963).

1204. Schoffa, G., and Grunewald, Th. Electron Spin Resonance Investigations on the Formation of Free Radicals in Amino Acids Through the Photoelectric Effect and the Compton Effect. Naturwissenschaften 51, 82 (1964).

1205. Sergeev, G. B., Gurman, V. S., Papisova, V. I., and Yakovenko, E. I. Principles Governing Free Radical Stabilization in Condensed Systems. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 63-1-63-13 (1961).

1206. Shigorin, D. N., Piskunov, A. K., Ozerova, G. A., Shcheglova, N. A., and Verein, N. V. Role of Hydrogen Bonds in Processes of Deactivation of Excited States of Molecules Leading to the Formation of Radicals. *Zh. Fiz. Khim.* 38, 2279 (1964).
1207. Siegel, Seymour, and Judeikis, Henry. Triplet-Triplet Energy Transfer in Rigid Glasses: Lack of a Solvent Effect. *J. Chem. Phys.* 41, 648 (1964).
1208. Simons, J. P., and Yarwood, A. J. Decomposition of Hot Radicals. II. Mechanisms of Excitation and Decomposition. *Trans. Faraday Soc.* 59, 90 (1963).
1209. Simons, J. P., and Yarwood, A. J. The Production of CF, CCl, and CBr Through the Decomposition of Energized Halogenomethyl Radicals. *Bull. Soc. Chim. Belges* 71, 651 (1962).
1210. Simpson, L. P., Kirby-Smith, J. S., and Randolph, M. L. Electron Spin Resonance (E.S.R.) in Photodynamic Dyes. *Nature* 199, 243 (1963).
1211. Smirnova, V. I., Zhuravleva, T. S., Shigorin, D. N., Gracheva, E. P., and Shostakovskii, M. F. The Electron Paramagnetic Resonance (E.P.R.) Spectra for Some  $\gamma$ - and Photo-Irradiated Disubstituted Acetylenes. *Zh. Fiz. Khim.* 38, 469 (1964).
1212. Smith, D. R., and Pieroni, J. J. Measurement of Electron Spin Resonance (E.S.R.) Difference Spectra at 77°K. Applications of the Method in Low-Temperature Radiation Chemistry. *Can. J. Chem.* 42, 2209 (1964).
1213. Steketee, J. W., and de Jonge, J. Sensitized Photoconductivity in Anthracene. *Koninkl. Ned. Akad. Wetenschap., Proc. Ser. B* 66, 76 (1963).
1214. Stevens, Brian, and Walker, Michael S. A Mechanism for Triplet-State Relaxation of Aromatic Molecules in a Fluid Environment. *Proc. Chem. Soc.*, 26 (1964).
1215. Suzuki, Atuo; Takahasi, Makoto, and Shiomi, Kengo. Photochemical Decomposition of  $\alpha, \alpha$ -Diphenyl- $\beta$ -picrylhydrazyl (DPPH) in Solution. I. Kinetic Study of the Reaction. *Bull. Chem. Soc. Japan* 36, 644 (1963).

1216. Suzuki, Atuo, Takahasi, Makoto, and Shiomi, Kengo. The Photochemical Decomposition of  $\alpha$ ,  $\alpha$ -Diphenyl- $\beta$ -picrylhydrazyl (DPPH) in Solution. II. Products of the Photolysis and Its Reaction Mechanism. *Ibid.*, 998 (1963).
1217. Takebayashi, Matsuji, Shingaki, Tadao, and Mitsuyama, Tadayoshi. The Photochemical Decomposition of Aromatic Azides in Thiols. The Decomposition in Thiophenol. *Sci. Repts. No. 10*, 35 (1961).
1218. Torozzolo, A. M., Murray, R. W., Smolinsky, G., Yager, W. A., and Wasserman, E. Electron Paramagnetic Resonance (E.P.R.) of Dicarbene and Dinitrene Derivatives. *J. Am. Chem. Soc.* 85, 2526 (1963).
1219. Tsepakov, V. F., and Shlyapintokh, V. Ya. Rate Constants for Elementary Reactions in the Oxidation of Ethylbenzene With Molecular Oxygen. *Kinetika i Kataliz* 3, 870 (1962).
1220. Tucker, B. G., and Whittle, E. The Trifluoroacetyl Radical. *Proc. Chem. Soc.*, 93 (1963).
1221. Tupikov, V. I., and Pshezhetskii, S. Ya. Migration of the Open Valence in Stabilized Olefin Radicals Under the Action of Light. *Dokl. Akad. Nauk SSSR* 156, 114 (1964).
1222. Ueberreiter, Kurt, and Burns, Wolfgang. Photo-sensitization of Decomposition of Tertalin Hydroperoxide. *Makromol. Chem.* 68, 24 (1963).
1223. Ueda, Hisashi. Electron Spin Resonance (E.S.R.) Studies of Irradiated Single Crystals of Creatinine and Creatine. *J. Chem. Phys.* 40, 901 (1964).
1224. Ueda, Hisashi. Electron Spin Resonance (E.S.R.) Studies of Irradiated Single Crystals of Sugars. *J. Phys. Chem.* 67, 2185 (1963).
1225. Ullman, Edwin F., and Milks, John E. Photochemical and Thermal Valence Tautomerization of 2,3-Diphenylindenone Oxide. II. *J. Am. Chem. Soc.* 86, 3814 (1964).

1226. Varneria, Robert E. An Attempt to Isolate Hot Radical Reactions in the Photochemical Decomposition of Acetone, Dimethyl Mercury, Propyl Iodide, and Isopropyl Iodide. NASA, Doc. N63-23750 (1963).

1227. van Beck, H. C. A., and Heertzes, P. M. Photochemical Reactions of Azo Dyes in Solution With Different Substrates. J. Soc. Dyers Colourists 79, 661 (1963).

1228. Wan, J. K. S., Hess, L. D., and Pitts, J. N., Jr. Free-Radical Addition to Azobenzene in Cumene Solution. Electron Paramagnetic Resonance Spectra of Some Long-Lived Radical Intermediates. J. Am. Chem. Soc. 86, 2069 (1964).

1229. Wettermark, Gunnar, and Dogliotti, Libera. Transient Species in the Photolysis of Anils. J. Chem. Phys. 40, 1486 (1964).

1230. Woodall, George N. C., and Gunning, Harry E. The Trapping by Nitric Oxide of Initially-Formed Free Radicals in Photochemical Reactions. I. The Mercury  $6(^3P_1)$  Photosensitized Decomposition of Propane and the Deuterated Propanes. Bull. Soc. Chim. Belges 71, 725 (1962).

1231. Yarwood, A. J., and Simons, J. P. Production of CF, CCl, and CBr Through the Decomposition of Energized Halomethyl Radicals. Proc. Chem. Soc., 62 (1962).

1232. Zandstra, P. J., and Evleth, E. M. Photolytic Decomposition of Aryldiazonium Salts. The p-Dimethylaminophenoxy Radical. J. Am. Chem. Soc. 86, 2664 (1964).

1233. Zimmerman, Howard E., and Wilson, Joseph W. Mechanistic and Exploratory Organic Photochemistry. IX. Phenyl Migration in the Irradiation of 4,4-Diphenylcyclohexenone. Ibid., 4036 (1964).

#### RADIOLYSIS.

1234. Adams, G. E., and Hart, Edwin J. Radiolysis and Photolysis of Aqueous Formic Acid. Carbon Monoxide Formation. J. Am. Chem. Soc. 84, 3994 (1962).

1235. Ahmed, M. T., and Swallow, A. J. Reaction Between Oxalyl Chloride and Saturated Hydrocarbons Induced by Ultraviolet Light and  $\gamma$ -Rays. *J. Chem. Soc.*, 3918 (1963).

1236. Alfimov, M. V., Buben, N. Y., Pristupa, A. I., and Shamshev, V. N. Excitation of the Triplet State in Naphthalene and Benzene Molecules by Fast Electrons. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1525 (1963).

1237. Anderson, Roy S., and Jaseja, Thadho S. Electron Resonance Examination of Trapped Radicals Resulting From Radiation Damage to Organic Single Crystals: Urea Compounds. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 2-1-2-9 (1961).

1238. Arai, Shigeyoshi, Maemori, Michio, Yamaguchi, Kenji, and Shida, Shoji. The Radiolysis and Photolysis of Cycloheptatriene. *Bull. Chem. Soc. Japan* 36, 590 (1963).

1239. Atkins, P. W., Keen, N., and Symons, M. C. R. Unstable Intermediates. XVI. Hyperfine Coupling From  $\alpha$ -Protons in Non-Planar Free Radicals: The  $\text{HPO}_2$  Radical. *J. Chem. Soc.*, 250 (1963).

1240. Ayscough, P. B., and Evans, H. E. Electron Spin Resonance (E.S.R.) Studies of Radical Reactions in Irradiated Alkyl Halides at Low Temperatures. *J. Phys. Chem.* 68, 3066 (1964).

1241. Ayscough, P. B., and Evans, H. E. Electron Spin Resonance Studies of  $\gamma$ -Irradiated Olefins and Ultraviolet-Irradiated Methyl Iodide Plus Olefin Glasses. *Trans. Faraday Soc.* 60, 801 (1964).

1242. Ayscough, P. B., and Thomson, C. Electron Spin Resonance Spectra of Alkyl Radicals in  $\gamma$ -Irradiated Alkyl Halides. *Ibid.* 58, 1477 (1962).

1243. Ayscough, P. B., Ivin, K. J., O'Donnell, J. M., and Thomson, C. Reactions in  $\gamma$ -Irradiated Alkyl Halides and Sulfides. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 4-1-4-21 (1961).

1244. Bagdasar'yan, Kh. S., and Sinitsyna, Z. A. Sensitized Formation of Radical-Ions of Aromatic Amines in the Radiolysis of Frozen Organic Glass. *Dokl. Akad. Nauk SSSR* 147, 1396 (1962).

1245. Bailey, A. J., Barker, S. A., and Stacey, M. Effects of  $\gamma$ -Radiation. VII. Irradiation of 2,3-Dihydro-4H-pyran and Related Compounds. *J. Chem. Soc.*, 1659 (1963).
1246. Bailey, A. J., Barker, S. A., and Stacey, M. Effects of  $\gamma$ -Radiation. VIII. Irradiation of D-Glucal in Aqueous Solution. *Ibid.*, 1663 (1963).
1247. Bensasson, R., Durup, M., Dworkin, A., Magat, M., Marx, R., and Szwarc, H. Role of Molecular Motions in Reactions of Radicals Produced by Irradiation and Trapped in Solid Matrixes. *Discussions Faraday Soc.*, No. 36, 177 (1964).
1248. Bensasson, R., Leibler, K., Marx, R., and Szwarc, H. E.P.R. (Electron Paramagnetic Resonance) Study of Some Free Radicals Produced by Irradiation in Solids at Low Temperatures. *Arch. Sci.* 13, 303 (1960).
1249. Bohner, George E. Basic Studies on Radiation Energy Transfer Mechanisms of Chemical Systems. US Dept. Com. Office. Tech. Serv., AD 401, 113, 95 pp. 1962.
1250. Box, Harold C., and Freund, Harold G. Paramagnetic Resonance Spectrum of Irradiated Single Crystals of L-Cystine Dihydrochloride. *J. Chem. Phys.* 40, 817 (1964).
1251. Brown, Daniel W., and Wall, Leo A. Radiation Induced Polymerization of Propylene at High Pressure. *J. Phys. Chem.* 67, 1016 (1963).
1252. Buben, N. Ya., Chkheidze, I. I., Koritskii, A. T., Molin, Ya. N., Shamshev, V. N., and Voevodskii, V. V. Electron Spin Resonance (E.S.R.) Investigations on Energy Transfer in Radiolysis of Organic Substances. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 1-10 (1961).
1253. Buben, N. Ya., Molin, Yu. N., Pristupa, A. I., and Shamshev, V. N. Electron Spin Resonance Spectrum of the Cyclohexyl Radical When Cyclohexane is Radiolyzed in the Gas-Crystal State. *Dokl. Akad. Nauk SSSR* 152, 352 (1963).
1254. Buben, N. Ya., Tolkachev, V. A., and Chkheidze, I. I. Radicals Yielded by Low-Temperature Radiolysis of Toluene. *Kinetika i Kataliz* 4, 683 (1963).

1255. Chachaty, C., and Hayon, E. Electron Spin Resonance (E.S.R.) Evidence of Radiation Electrons Trapped in Organic Glasses at 77°K. Nature 200, 59 (1963).

1256. Chachaty, Claude, and Marx, Rose. Interpretation of the Electronic Paramagnetic Resonance (E.P.R.) Spectrum of Irradiated Solid Formaldehyde. J. Chim. Phys. 59, 792 (1962).

1257. Chernova, A. I., and Mints, S. Ya. Reduction of Ferric Ions Caused by the Effect of  $\gamma$ -Radiation on Aqueous Solutions Containing Certain Organic Substances. Nukleonika 4, No. 4, 14 (1959).

1258. Chkhcheidze, I. I., Trofimov, V. I., and Buben, N. Ya. Radicals Formed on Radiolysis of Some Derivatives of Benzene. Zh. Strukt. Khim. 5, 624 (1964).

1259. Clendinning, William R. Free-Radical Yield Produced in 1-Bromobutane by Irradiation With Monochromatic X-Rays of Differing Photon Energies. US At. Energy Comm. TID-12356, 213 pp. 1960.

1260. Colebourne, N., Collinson, E., and Dainton, F. S.  $^{60}\text{Co}$   $\gamma$ -Radiolysis of N,N-dimethylformamide. Trans. Faraday Soc. 59, 886 (1963).

1261. Continental Oil Co. Telomerizing Ethylene With Halogenated Methanes by  $\gamma$ -Radiation. Brit. 905,113, September 5, 1962.

1262. Cook, R. J., Rowlands, J. R., and Whiffen, D. H. Electron Spin Resonance Spectra of Irradiated Monofluoroacetamide. Mol. Phys. 7, 31 (1963).

1263. Cook, R. J., Rowlands, J. R., and Whiffen, D. H. The Electron Spin Resonance (E.S.R.) Spectra of  $\gamma$ -Irradiated Fumaric Acid. J. Chem. Soc., 3520 (1963).

1264. Corth, Richard. The Radiolysis of Normal and Secondary Butyl Chloride. Univ. Microfilms, Order No. 64-312.

1265. Cunningham, Joseph. Radiation Chemistry of Ionic Solids. III. Chemical Studies on the Formation and Annealing of Radicals in Irradiated Nitrates. J. Phys. Chem. 67, 1772 (1963).

1266. Cunningham, Joseph. Radical Species Detected in  $\gamma$ -Irradiated Nitrate Crystals by Electron Paramagnetic Resonance (E.P.R.) and Ultraviolet Spectral Studies. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 13-1-3 (1961).

1267. Czapski, Gideon, and Bielski, Benon H. J. The Formation and Decay of  $H_2O_3$  and  $HO_2$  in Electron-Irradiated Aqueous Solutions. *J. Phys. Chem.* 67, 2180 (1963).

1268. Czapski, Gideon, Rabani, Joseph, and Stein, Gabriel. Reactivity of Hydrogen Atoms With Ethanol and Formate in Aqueous Solution. *Trans. Faraday Soc.* 58, 2160 (1962).

1269. Dainton, F. S., and Watt, W. S. The Effect of pH on the Radical Yields in the  $\gamma$ -Radiolysis of Aqueous Systems. *Nature* 195, 1294 (1962).

1270. Dainton, F. S., Keene, J. P., Kemp, T. J., Salmon, G. A., and Teply, J. Pulse Radiolysis and Matrix Isolation Data for Methanol and 2-Methyltetrahydrofuran (MTHF). *Proc. Chem. Soc.* 265 (1964).

1271. Dainton, F. S., Kemp, T. J., Salmon, G. A., and Keene, J. P. Formation of Triplet States of Solutes in the Radiolysis of Organic Liquids. *Nature* 203, 1050 (1964).

1272. Damerau, Werner, Lassmann, Guenter, and Thom, Hans Guenter. Electron Spin Resonance (E.S.R.) Investigations on Some Cyclic Oligomers of Caprolactam After  $\gamma$ -Irradiation. *Z. Physik. Chem.* 223, 59 (1963).

1273. Damerau, Werner, Lassmann, Guenter, and Thom, Hans Guenter. Tritium Substitution for Electron Spin Resonance Investigations. *Ibid.*, 99 (1963).

1274. Dorfman, Leon M. Pulse Radiolysis: Fast Reaction Studies in Radiation Chemistry. *Radiation Res. Proc. Intern. Conf.*, Natick, Mass., 59 (1963).

1275. Eberhardt, Manfred K. Cyclohexadiene Formation in the  $\gamma$ -Radiolysis of Liquid Benzene. *J. Phys. Chem.* 67, 2856 (1963).

1276. Eda, B., Cook, R. J., and Whiffen, D. H. Electron Spin Resonance of  $\gamma$ -Irradiated Thiophene 2-Carboxylic Acid. *Trans. Faraday Soc.* 60, 1497 (1964).

1277. Ehrenberg, A., Ehrenberg, L., and Lofroth, G. Thymidine-Like Electron Spin Resonance (E.S.R.) Spectra in  $\gamma$ -Irradiated Deoxyribonucleic Acid (DNA). *Nature* 200, 376 (1963).

1278. Ermolenko, I. N., Potapovich, A. K., and Makatun, V. N. The Study by Spectroscopy Methods of the Electronic Paramagnetic Resonance (E.P.R.) of the  $\gamma$ -Irradiated Cellulose Materials. *Vestsi Akad. Navuk Belarusk. SSR, Ser. Fiz.-Tekhn. Navuk*, 65 (1963).

1279. Ershov, B. G., Pikaev, A. K., Glazunov, P. Ya., and Spitsyn, Vlkt. I. Proff, by the Electron Paramagnetic Resonance (E.P.R.) Method, of the Participation of the Trapped Electron in Radiation-Chemical Reactions in Frozen Aqueous Solutions. *Dokl. Akad. Nauk SSSR* 154, 899 (1964).

1280. Evans, E. Anthony, and Stanford, F. G. Decomposition of Tritium-Labeled Organic Compounds. *Nature* 197, 551 (1963).

1281. Feng, P. Y., and Krotoszynski, B. K. A Study of Free Radicals and Other Intermediate Species and Internal Energy Transfer Processes in Irradiated Chemical Systems. US At. Energy Comm. ASD-TDR-62-540, 1962.

1282. Feng, P. Y., Glasson, W. A., and Marshall, S. A. The Nature of Free Radicals in Irradiated Chemical (Aliphatic) Systems. US Dept. Com., Office Tech. Serv., PB Rept. 171,596, 64 pp. 1960.

1283. Fenrick, Harold W., Filaeth, Stephen V., Hanson, Allen L., and Willard, John E. Differences in Electron Spin Resonance (E.S.R.) Spectra and Annealing Characteristics of Radicals Produced in Polycrystalline and Glassy Alkyl Iodides by  $\gamma$ -Radiolysis. *J. Am. Chem. Soc.* 85, 3131 (1963).

1284. Fischen, H., and Hellwege, K. H. Electron Spin Resonance (E.S.R.) Investigations of Irradiated Monocrystals of  $\epsilon$ -Caprolactam. *Z. Naturforsch.* 18a, 994 (1963).

1285. Florin, Roland E., and Wall, Leo A. Electron Spin Resonance (E.S.R.) of  $\gamma$ -Irradiated Cellulose. *J. Polymer Sci. Pt. A* 1, 1163 (1963).

1286. Frankevich, E. L., and Tal'roze, V. L. Free Radicals and Electrical Phenomena in Irradiated Solid Substances. Tr. 2-go Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 651 (1960).
1287. Fujimoto, Minoru. Electron Spin Resonance (E.S.R.) Studies of Radicals Formed by X-Ray Irradiation of  $\alpha$ -Aminoisobutyric Acid. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 20-1-20-12 (1961).
1288. Fujimoto, Minoru. Electron Spin Resonance of a Radical in Irradiated Single Crystals of Itaconic Acid. J. Chem. Phys. 39, 846 (1963).
1289. Gale, L. H., and Wagner, C. D. A Kinetic Analysis of Short-Chain, Radiation-Initiated Addition Reactions. J. Am. Chem. Soc. 86, 4531 (1964).
1290. Gordy, Walter. Electron Spin Resonance (E.S.R.) Investigations of Proteins. US Dept. Com., Office Tech. Serv., AD 262,001, 10 pp., 1961.
1291. Grishina, A. D. Primary Radical Products of Poly(Vinyl Alcohol) Radiolysis, as Investigated by Means of E.S.R. (Electron Spin Resonance). Dokl. Akad. Nauk SSSR 150, 809.
1292. Guarino, John P., and Hamill, William H. Ionic Intermediates in  $\gamma$ -Irradiated Organic Glasses at -196°. J. Am. Chem. Soc. 86, 777 (1964).
1293. Hahn, Yu Hak, and Rexroad, H. N. Electron Spin Resonance (E.S.R.) in a  $\gamma$ -Irradiated Single Crystal of Mercaptosuccinic Acid. J. Chem. Phys. 28, 1599 (1963).
1294. Hanna, Melvin W., and McConnell, Harden M. Radiation Damage in Organic Crystals. III. Long Polyene Radicals. Ibid. 37, 3008 (1963).
1295. Hayes, W., Jones, G. D., and Twidell, J. W. Paramagnetic Resonance and Optical Absorption of Irradiated  $\text{CaF}_2:\text{Ho}$ . Proc. Phys. Soc. 81, 371 (1963).

1296. Hearne, J. A., and Hummel, R. W. Radiolytic Oxidation of Methane. I. Production of Methyl Hydroperoxide and HCHO. At. Energy Res. Estab. Repts. AERE-R 4581 (1964).

1297. Heller, H. C., and Cole, T. Electron Magnetic Resonance (E.P.R.) of  $\alpha$ -Irradiated Potassium Hydrogen Maleate. J. Am. Chem. Soc. 84, 4448 (1962).

1298. Henriksen, Thormod. Electron Spin Resonance (E.S.R.) Studies on Irradiated Frozen Aqueous Solutions of Sulfur Compounds. J. Chem. Phys. 38, 1926 (1963).

1299. Henriksen, Thormod. Radiation-Induced Free Radicals in Frozen Aqueous Solutions of Glycine. Radiation Res. 17, 158 (1962).

1300. Henriksen, Thormod. Radiation-Induced Free Radicals in Sulfur Compounds. Electron Spin Resonance (E.S.R.) Studies in the Polycrystalline State. J. Chem. Phys. 37, 2189 (1962).

1301. Hentz, Robert R. Radiation-Induced Reactions of Isopropylbenzene on Silica-Alumina. J. Phys. Chem. 68, 2889 (1964).

1302. Higuchi, Jiro. Electron Spin Density in Irradiated Oriented Polyethylene. J. Chem. Phys. 39, 2366 (1963).

1303. Higuchi, Jiro. Isotropic Proton Hyperfine Interaction and Properties of the CH Bond. Ibid., 3455 (1963).

1304. Holroyd, Richard A. Evidence for Radical Isomerization During Radiolysis. US At. Energy Comm. RRL-39. 4 pp. 1960.

1305. Holroyd, Richard A., and Klein, George W. Detection of Radical Intermediates in the Radiolysis of Hydrocarbons With the Ethylene-C<sup>14</sup> Scavenging Technique. J. Am. Chem. Soc. 84, 4000 (1962).

1306. Hughes, Floyd, Kirk, Russell D., and Patten, Frank W. Radiolysis of Simple Aromatics in Boric Acid Glass. J. Chem. Phys. 40, 872 (1964).

1307. Hughes, W. E., and Moulton, W. G. Electron Spin Resonance of Irradiated KH<sub>2</sub>PO<sub>4</sub> and KD<sub>2</sub>PO<sub>4</sub>. Ibid. 39, 1359 (1963).

1308. Hummel, Andries, and Allen, A. O. Radiation Chemistry of Aqueous Solutions of Ethanol and the Nature of the Oxidizing Radical OH. *Radiation Res.* 17, 302 (1962).

1309. Ingalls, R. B., and Kivelson, D. Analysis of Electron Spin Resonance Spectra Observed in Irradiated Aromatic Systems. *J. Chem. Phys.* 38, 1907 (1963).

1310. Iwasaki, Machio, and Itoh, Koichi. Electron Spin Resonance of an Irradiated Crystal of Potassium Hydrogen Maleate. *Bull. Chem. Soc. Japan* 37, 44 (1964).

1311. Johnson, R. A. A Review of Free Radical Addition Reactions Initiated by High-Energy Radiation. *At. Energy Res. Estab. Rept. R4587*. 3 pp. 1964.

1312. Johnson, Russell H., and Becker, D. A. The Radiation Chemistry of Some of the Higher Aliphatic Alcohols. Further Studies on Radicals Trapped at Low Temperatures. *J. Phys. Chem.* 67, 531 (1963).

1313. Kallmann, H., Riedl, W., and Wotherspoon, N. High-Energy-Induced Free-Radical Formation in  $C_6H_6$ - $CCl_4$  Mixtures. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 29-1-4 (1961).

1314. Kashiwabara, Hisatsugu. Electron Spin Resonance (E.S.R.) Studies of Irradiated Polyethylene. II. Considerations on the Decays of Free Radicals. *Japan. J. Appl. Phys.* 3, 384 (1964).

1315. Kashiwagi, Michio. Electron Spin Resonance (E.S.R.) of an  $\alpha$ -Irradiated Single Crystal of Hexamethylenediammonium Adipate. *Nippon Kagaku Zasshi* 85, 91 (1964).

1316. Katayama, M., Whitmers, J. C., and Trumbore, C. N. A Comparison of the Radiolysis and Photolysis of Cyclopentanone. *J. Am. Chem. Soc.* 84, 4025 (1962).

1317. Kazanskii, V. B., Pariiskii, B. G., and Voevodskii, V. V. Use of Electron Paramagnetic Resonance (E.P.R.) for the Study of Hydrogen Atom Properties and Defects Obtained by Irradiation of Silica Gel. *Tr. 2-go Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow*, 656 (1960).

1318. Kim, Y. W., and France, P. W. Electron Paramagnetic Resonance (E.P.R.) Absorption Studies of Neutron-Irradiated  $\alpha$ , $\alpha$ -Diphenyl- $\beta$ -picryl Hydrazine. *J. Chem. Phys.* 38, 1453 (1963).

1319. Knight, James A. Radiation Chemistry of Organic Systems. US At. Energy Comm. TID-19341. 34 pp. 1962.

1320. Kondo, M., Ronayne, M. R., Guarino, J. P., and Hamill, W. H. Photoionization and  $\gamma$ -Induced Oxidation of Aromatic Amines in Rigid Organic Glasses. *J. Am. Chem. Soc.* 86, 1297 (1964).

1321. Kotov, A. G., and Pshezhetskii, S. Ya. Study of Annihilation of Ion Radicals in Ionic Crystals by the E.P.R. Method. *Zh. Fiz. Khim.* 38, 1926 (1963).

1322. Kotov, A. G., and Pshezhetskii, S. Ya. Study of Radical Formation in  $\gamma$ -Irradiation of Some Ammonium and Hydrazinium Salts by the Electron Paramagnetic Resonance (E.P.R.) Method. *Ibid.*, 1920 (1964).

1323. Kotov, A. G., Pshezhetskii, S. Ya., Milinchuk, V. I., Tupikov, V. I., and Tsaienko, V. I. Formation and Recombination of Radicals During the  $\gamma$ -Radiation of Frozen Hydrogen Peroxide-Water Solutions. *Kinetika i Kataliz* 4, 926 (1963).

1324. Kourim, P., and Vacek, K. Electron Paramagnetic Resonance Spectrum of  $\gamma$ -Irradiated Poly (Methyl Methacrylate) Specifically Deuterated in the Methylene Group. *Tetrahedron Letters*, 1051 (1962).

1325. Lassmann, G. Radiation-Induced Radical Formation in the System  $H_2O$ -Amino Acid. *Z. Physik. Chem.* 225, 409 (1964).

1326. Lassmann, G., Damerau, W., and Herzmann, H. Electron Spin Resonance (E.S.R.) Investigations of the Autoradiolysis of Tritium-Activated Amino and Dicarboxylic Acids. *Z. Naturforsch.* 19a, 661 (1964).

1327. Lebedev, Ya. S., and Tevetkov, Yu. D. Electron Paramagnetic Resonance (E.P.R.) Spectra of Radicals Formed by the Irradiation of Polypropylene. *Zh. Strukt. Khim.* 2, 607 (1961).

1328. Lee, Sook, and Bray, P. J. Electron Spin Resonance Studies of Irradiated Glasses Containing Boron. *J. Chem. Phys.* 39, 2863 (1963).

1329. Lenk, R. Changes in E.P.R. (Electron Paramagnetic Resonance) Spectrum of Free Radical Species in  $\gamma$ -Irradiated Polyformaldehyde. *Czech. J. Phys.* 12, 833 (1962).

1330. Lenk, R. Interpretation of Electron Paramagnetic Resonance (E.P.R.) Spectrum of Free Radicals in  $\gamma$ -Irradiated Methanol. *Ibid.* 13, 841 (1963).

1331. Levins, Philip L., and Sliney, Philip M. Radical-Molecule Complexes as Intermediates in Low-Temperature Radiation Chemistry. US At. Energy Comm. TID-19671. 32 pp. 1963.

1332. Lin, W. C., and McDowell, C. A. Electron Spin Resonance (E.S.R.) of an X-Ray-Irradiated Single Crystal of Diketopiperazine. *Can. J. Chem.* 41, 9 (1963).

1333. Lofroth, G., Ehrenberg, L., and Ehrenberg, A. Radiation-Induced Free Radicals in Carbohydrates and an Estimation of Their Concentration. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 38-1-38-6 (1961).

1334. Lontz, Robert, and Gordy, Walter. Fluorine Hyperfine Interaction in the Electron Spin Resonance (E.S.R.) of Irradiated Organic Single Crystals. Paramagnetic Resonance, Proc. Intern. Conf., 1st, Jerusalem 2,795 (1962).

1335. Lorquet, A. J. Radiolysis of Propylamine. *Bull. Soc. Roy. Sci. Liege* 32, 845 (1963).

1336. Loy, B. R. Electron Spin Resonance (E.S.R.) of Polypropylene. *J. Polymer Sci. Pt. A*. 1, 2251 (1963).

1337. McDowell, C. A., and Horsfield, A. J. Electron Spin Resonance (E.S.R.) Spectroscopy of Radicals Formed by  $\alpha$ -Irradiation of Amino Acids and Related Compounds. Intern. Symp. Free Radical Stabilization, 4th, Washington, D.C., D-IV-1-D-IV-6 (1959).

1338. McDowell, C. A., and Lin, W. C. Electron Spin Resonance of Trapped Radicals Produced by the X-Ray Irradiation of DL-Valine. Proc. Intern. Symp. Mol. Struct. Spectry., Tokyo (1962).

1339. Milyutinskaya, R. I., and Bagdasar'yan, Kh. S. Sensitized Formation of Cation Radicals During the Low-Temperature Radiolysis of Films Containing Aromatic Amines. *Zh. Fiz. Khim.* 38, 776 (1964).

1340. Misiti-Dorello, P., Boccacci, M., and Quintiliani, M. Formation of Cysteamine From Cystamine, Induced by X-Rays in the Presence of Thiol Reagents. *Atompraxis* 10, 163 (1964).

1341. Miyagawa, Ichiro. Electron Spin Resonance (E.S.R.) of an x-Irradiated Single Crystal of 1,4-Diketopiperazine. *US At. Energy Comm.* NP-13199. 17 pp. 1961.

1342. Moenig, H., and Koch, R. Electron Spin Resonance (E.S.R.) Investigations of Ultraviolet and x-Irradiated Methionine. *Nature* 202, 289 (1964).

1343. Molin, Yu. N., Chkheidze, I. I., Kaplan, E. P., Buben, N. Ya., and Voevodskii, V. V. Formation of Radicals in Radiolysis of Solid Organic Compounds. I. Comparison of the Radical Yields in the Different Organic Compounds. *Kinetika i Kataliz* 2, 674 (1962).

1344. Molin Yu. N., Chkheidze, I. I., Kaplan, E. P., Buben, N. Ya., and Voevodskii, V. V. Radical Formation in Radiolysis of Solid Organic Substances. II. Radical Yields in Benzene and Biphenyl Derivatives. *Ibid.* 4, 557 (1963).

1345. Molin, Yu. N., Chkheidze, I. I., Petrov, Al. A., Buben, N. Ya., and Voevodskii, V. V. Energy Transfer in Radiolysis of Certain Frozen Hydrocarbons. *Dokl. Akad. Nauk SSSR* 131, 125 (1960).

1346. Molin, Yu. N., Koritskii, A. T., Shamshev, V. N., and Buben, N. Ya. Temperature Changes in the Electron Spin Resonance (E.P.R.) Spectra of Allyl and Other Radicals in Irradiated Polymers. *Vysokomolekul. Soedin.* 4, 690 (1962).

1347. Morton, J. R., and Falconer, W. E. Electron Spin Resonance Spectrum of XeF in  $\gamma$ -Irradiated Zenon Tetrafluoride. *J. Chem. Phys.* 39, 427 (1963).

1348. Moulton, Grace Charbonnet. Paramagnetic Resonance of x-Irradiated Single Crystals of Rochelle Salt. Univ. Microfilms, Order No. 63-2049.

1349. Narasimha Rao, D. V. G. L., and Gordy, Walter. Electron Spin Resonance (E.S.R.) of an Irradiated Single Crystal of Urea Oxalate. US Dept. Com., Office Tech. Serv., AD 262, 001, 6 pp. 1961.
1350. Nehari, Shlomo, and Rabani, Joseph. The Reaction of H Atoms With OH<sup>-</sup> in the Radiation Chemistry of Aqueous Solutions. J. Phys. Chem. 67, 1609 (1963).
1351. Nepomayashchii, A. I., Muromtsev, V. I., and Bagdasar'yan, Kh. S. Formation of Ion-Radicals Under the Action of  $\gamma$ -Rays in the Tetrahydrofuran-Styrene System at -196°. Dokl. Akad. Nauk SSSR 149, 901 (1963).
1352. Nikol'skii, V. G., Chkheidze, I. I., and Buben, N. Ya. Oxidation of Alkyl Radicals During  $\gamma$  Transitions in Amorphous Materials. Kinetika i Kataliz 5, 82 (1964).
1353. O'Donnell, J. H., McGarvey, B. and Morawetz, H. Polymerization in the Crystalline State. VI. Electron-Spin Resonance Study of the Propagating Species in a Polymerizing Single Crystal of Barium Methacrylate Dihydrate. J. Am. Chem. Soc. 86, 2322 (1964).
1354. Ormerod, M. G., and Charlesby, A. Radiation Chemistry of Some Polysiloxanes: An Electron Spin Resonance (E.S.R.) Study. Polymer 4, 459 (1963).
1355. Orszagh, Andrzej, Czarnodola, Helena, Gorska, Zofia, and Zurakowska-Orszagh, Janina. Effect of  $\gamma$ -Radiation on Aliphatic Polyesters. I. Polish Acad. Sci., Inst. Nucl. Res., Rept. No. 306/XVII (1962).
1356. Overfull, D. W., and Mueller, K. A. Electron Spin Resonance (E.S.R.) in  $\gamma$ -Irradiated Triglycine Sulfate. Helv. Phys. Acta 34, 786 (1961).
1357. Pascaru, I., Constantinescu, M., and Constantinescu, O., Electronic Paramagnetic Resonance (E.P.R.) Study of Glycine Irradiated in a Reactor. Acad. Rep. Populare Romane, Studii Cercetari Fiz. 14, 393 (1963).
1358. Patten, Raymond A., and Gordy, Walter. Electron Spin Resonance Investigations of Radiation-Induced Free Radicals in Ribonucleic Acid (RNA) and Deoxyribonucleic Acid (DNA) at Low Temperatures: Effect of Water. Nature 201, 361 (1964).

1359. Phillips, G. O., and Baugh, P. Molecular Environment Effects in the Radiation Decomposition of  $\alpha$ -D-Glucose. *Ibid.* 198, 282 (1963).

1360. Pihl, A., Sanner, T., and Henriksen, T. Effect of Irradiation Temperature on the Yield of Solute Radicals in Frozen Aqueous Solutions. *Acta Chem. Scand.* 17, 2124 (1963).

1361. Proskurnin, M. A., Bakerkin, A. S., and Krushinskaya, N. P. The Influence of Solid Substances on the Decomposition of  $CCl_4$  Mixtures With Water Under the Influence of  $\gamma$ -Radiation. *Tr. 2-go Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow*, 274 (1960).

1362. Przybylowicz, Z. V., Krongauz, V. A., and Bagdasar'yan, Kh. S. Study of the Radiolysis of Some Hydrocarbons by the Methods of Gas Chromatography and Electron Paramagnetic Resonance. *Kinetika i Kataliz* 4, 489 (1963).

1363. Revina, A. A., and Bakh, N. A. Free Radical Reactions During the Interaction of Oxygen With Irradiated Potassium Palmitate. *Dokl. Akad. Nauk SSSR* 155, 410 (1964).

1364. Revina, A. A., and Podsolbyaev, A. P. Study of the Radiolysis of Piperidine by the Electron Paramagnetic Resonance (E.P.R.) Method. *Ibid.* 152, 668 (1963).

1365. Roberts, John, and Hamill, William H. Ionic and Free-Radical Processes in Liquid Mixtures Containing Hydrocarbons. *J. Phys. Chem.* 67, 2446 (1963).

1366. Rogers, M. T., and Whiffen, D. H. Electron Spin Resonance of Irradiated Crystals of Sodium Perfluorosuccinate. *J. Chem. Phys.* 40, 2662 (1964).

1367. Rondeau, Roger E. Radiochemical Production and Fate of Free Radicals. US Dept. Com., Office Tech. Serv., PB Rept. 171, 310, 23 pp. 1960.

1368. Rondeau, Roger E. Vacuum Techniques in Radiation Chemistry. NASA Doc. N63-10741 (1962).

1369. Rothschild, Mary Louise. Mechanism for the Transformation of Ferriprotoporphyrin by a Cobalt-60  $\gamma$ -Ray-Initiated Chain Reaction. *Radiation Res.* 17, 50 (1962).

1370. Schindler, Ralph N. Radiolysis of Ethyl Iodide in the Liquid Phase. *Radiochim. Acta* 2, 69 (1963).

1371. Schindler, Ralph N. The Gas-Phase Radiolysis of Ethyl Chloride. *Ibid.*, 62 (1963).

1372. Schoffa, George. Electron Spin Resonance (E.S.R.) in Irradiated Single Crystals of Betaine Hydrochloride. *J. Chem. Phys.* 40, 908 (1964).

1373. Schuler, Robert H., and Kuntz, Robert R. Methyl Radical Production in the Radiolysis of Hydrocarbons. *J. Phys. Chem.* 67, 1004 (1963).

1374. Schulte-Frohlinde, Dietrich, and Erhardt, Friedrich. 5, 12-Diphenyl-7-hydroxydinaphtho(1,2-b,2',3'-d)furan as Radical Scavenger in the  $\gamma$ -Radiolysis of Organic Solvents. *Ann.* 671, 88 (1964).

1375. Schwartz, Larry L., and Firestone, Richard F. The Radiolysis of Dibromodichloromethane and the  $Co^{60}$  Gamma-Ray Induced Exchange Between  $CCl_2Br_2$  and  $Br_2$ . US At. Energy Comm. TID-16579. 12 pp. (1962).

1376. Sharpatyi, V. A., Molin, Yu. N., Ermolaev, V. K., Zhuravlev, T. S., and Proskurnin, M. A. Investigation of the Radiolysis of the Aqueous Solutions by Using an Electron Paramagnetic Resonance (E.P.R.) Method. *Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go Soveshch.* Leningrad 2, 100 (1960).

1377. Shul'ga, S. Z., and Telyatnik, A. I. Structure and Orientation of the Stabilized Free Radical in a  $\gamma$ -Irradiated DL-Valine Single Crystal Determined by the Method of Electron Paramagnetic Resonance (E.P.R.). *Ukr. Fiz. Zh.* 9, 185 (1964).

1378. Shul'ga, S. Z., Telyatnik, A. I., Taranukha, O. M., and Sidorik, E. P. E.P.R. (Electron Spin Paramagnetic Resonance) Spectra of Certain  $\gamma$ -Irradiated Amino Acids Over a Wide Temperature Range. *Ibid.* 8, 460 (1963).

1379. Siegel, Seymour. Model for OH-Radical Stabilization in Ice at 77°K, Under  $\gamma$ -Irradiation. *J. Chem. Phys.* 39, 190 (1963).
1380. Singh, Ajit, and Freeman, Gordon R. Radiolysis of Cyclohexanone. I. Pure Liquid. *Can. J. Chem.* 42, 1869 (1964).
1381. Singh, Ajit, and Freeman, Gordon R. Radiolysis of Cyclohexanone. II. Effects of Solutes on Products Involving C-H Bond Rupture. *Ibid.*, 1877 (1964).
1382. Smaller, Bernard, and McMillan, Juan. Free Radical Species Produced by Radiation in  $H_2O$  and  $H_2O_2$  at Low Temperatures. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 65-1-3 (1961).
1383. Smirnova, V. I., Zhuravleva, G. S., Yanova, K. G., and Shigorin, D. N. Study by the Electron Paramagnetic Resonance (E.P.R.) Method of the Structure and Behavior of Radicals Formed on  $\gamma$ -,  $\beta$ -, and Photolrradiation of Acetaldehyde and Formaldehyde. *Zh. Fiz. Khim.* 38, 742 (1964).
1384. Smirnova, V. I., Shigorin, D. N., and Zhuravleva, T. S. Electron Paramagnetic Resonance (E.P.R.) Spectra of  $\gamma$ -Irradiated Compounds With Multiple Bonds. *Inv. Akad. Nauk SSSR, Ser. Fiz.* 27, No. 1, 78 (1963).
1385. Sorokin, Yu. A., Tsivenko, V. I., and Pshezhetskii, S. Ya. Formation of Hydrazine During the  $\gamma$ -Irradiation of Liquid Ammonia and of Aqueous Ammoniacal Solutions. *Zh. Fiz. Khim.* 37, 1871 (1963).
1386. Staples, J. A., III. Electron Spin Magnetic Resonance of Free-Radical Intermediates in  $\gamma$ -Irradiated Hydrocarbons. US At. Energy Comm. NARF-63-4T, 93 pp. 1963.
1387. Swarc, Henri. The Electron Spin Resonance (E.S.R.) Study of the Recombinations of Radicals Produced in Cyclohexane by Irradiation With  $\gamma$ -Rays at 77°K. *J. Chim. Phys.* 59, 1067 (1962).
1388. Symons, M. C. R. Unstable Intermediates. XVIII. Free Radicals in Poly(Methyl Methacrylate). *J. Chem. Soc.*, 1186 (1963).
1389. Symons, M. C. R. Unstable Intermediates. XIX. Electron-Ejection and -Trapping in Molecular Solids. *Ibid.*, 1189 (1963).

1390. Tamura, N. Application of the Electron Spin Resonance (E.S.R.) in Radiation Chemistry. *Genshiryoku Kagaku* 9, 7 (1963).
1391. Tench, A. J. Electron Spin Resonance (E.S.R.) in an Irradiated Single Crystal of Tetramethyl Ammonium Chloride. *J. Chem. Phys.* 38, 593 (1963).
1392. Tench, A. J. Radiation Damage in Solid Tetramethylammonium Halides. Free Radicals Stable at Low Temperatures. *J. Phys. Chem.* 67, 923 (1963).
1393. Truby, Frank K., MacCallum, Crawford, and Hesse, James E. E.S.R. (Electron Spin Resonance) Studies of  $\gamma$ -Irradiated n-Octadecyl Disulfide. *J. Chem. Phys.* 37, 2777 (1962).
1394. Tsuchi, Minoru. Hydroxyl Radicals in the  $\gamma$ -Radiolysis of Aqueous Benzene Solutions. *Bull. Chem. Soc. Japan* 56, 1582 (1963).
1395. Tayetkov, Yu. D. Electron Spin Resonance of  $\alpha$ -Irradiated Lysine Mononydrochloride Dihydrate. *Trans. Faraday Soc.* 59, 2213 (1963).
1396. Tupikov, V. I., and Psheznetskii, S. Ya. Formation and the Reaction of Free Radicals in Solid Ammonia and Hydrazine, Which is formed by the Action of  $\gamma$ -Rays. *Zh. Fiz. Khim.* 37, 1900 (1963).
1397. Ueda, Hisashi. Electron Spin Resonance (E.S.R.) Studies of Irradiated Single Crystals of D-Fructose and L-Sorbose. *J. Phys. Chem.* 67, 966 (1963).
1398. van de Vorst, A., and Williams-Dorlet, C. Free Radicals Induced by  $\gamma$ -Irradiation of Constitutive Bases of Deoxyribonucleic Acid. *Proc. Colloq. AMPERE* 11, 398 (1962).
1399. Van Sickle, Dale E., and Redeker, Harry E. Radiolysis of Aromatic Alcohols. *Radiation Res.* 21, 256 (1964).
1400. Votinov, M. P., Koenob, M. A., Kuzicheva, E. A., Evdokomov, V. F., and Antuf'ev, V. V. E.P.R. (Electron Paramagnetic Resonance) Spectra of  $\gamma$ -Irradiated Solid Carbohydrates. *Tr. Z.-go Vses. Soveshch. po Radiats. Khim.*, Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 335 (1960).

1401. Walling, Cheves, and Gibian, Morton J. Hydrogen Abstraction by the Triplet State of Benzophenone. *J. Am. Chem. Soc.* 86, 3902 (1964).

1402. Wang, Li-Hwei. Diffusion Kinetics of Free Radicals in Radiation Chemistry. *Hau Bsuek Tung Pao No. 3*, 12 (1963).

1403. Weiner, Ruth F., and Koski, W. S. Electron Spin Resonance (E.S.R.) Study of Free Radicals in Irradiated Glycine. *J. Am. Chem. Soc.* 85, 873 (1963).

1404. Weissbluth, M., and Scalapino, D. Radiation-Induced Free Radicals of Short Lifetime. *US Dept. Com., Office Tech. Serv.*, AD 259,539, 30 pp. 1961.

1405. Wendenburg, J. The  $\gamma$ -Radiolysis of o- and m-Dichlorobenzene. *Z. Naturforsch.* 19b, 187 (1964).

1406. Whiffen, D. H. Electron Spin Resonance Studies on the Geometry of Trapped Radicals. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, A4-1-A4-4. (1961).

1407. Yang, Kang. Free-Radical Reactions Initiated by Ionizing Radiation. II. Rate Constants for Hydrogen-Atom Addition Reactions With Monoolefins, Butadiene, and Benzene. *J. Am. Chem. Soc.* 84, 3795 (1962).

1408. Yanova, K. G., and Sharpatyi, V. A. Electron Paramagnetic Resonance (E.P.R.) Spectra of Radicals Arising From Radiolysis of Some Five-Membered Heterocyclics. *Optika i Spektroskopiya, Akad. Nauk SSSR, Otd. Fiz.-Mat. Nauk, Sb. Statei* 2, 73 (1963).

1409. Yoskii, Giichi. Free Radicals in Aqueous Solution of Glycine Being Irradiated by Tritiated Water. *Radioisotopes* 12, 286 (1963).

1410. Yoshii, Giichi. Physicochemical Properties of Aqueous Solution(s) of Glycine Being Irradiated by Tritiated Water. *Ibid.* 13, 170 (1964).

1411. Zagorski, Z. P. Free Radicals in the Chain Reaction of  $\gamma$ -Radiation Induced Reduction of Oxygen. *Preprints Papers Intern. Symp. Free Radicals*, 5th, Uppsala, 75-i-75-7 (1961).

1412. Zarifyants, Yu. A., Kiselev, V. G., and Fedorov, G. G. Adsorption of Free Radicals Formed on Solid Surfaces by Cleavage and by ionizing Radiation. *Ibid.*, 33-1-12 (1961).

1413. Zwiebel, Imre, and Bretton, Randolph H. Free Radical Yields in n-Alcohols Resulting From  $\gamma$ -Irradiation. *A. I. Ch.E. J.* 10, 339 (1964).

#### ELECTRIC AND MAGNETIC PHENOMENA.

1414. Adams, Ralph N. Application of Electron Paramagnetic Resonance Techniques in Electrochemistry. *J. Electroanal. Chem.* 8, 151 (1964).

1415. Adrian, Frank J., and Karplus, Martin.  $\beta$ -Proton Hyperfine Splittings in the Vinyl Radical. *J. Chem. Phys.* 41, 56 (1964).

1416. Barber, M., Farren, J., and Linnett, J. W. The Mass Spectrometric Study of the Reaction of Methyl Radicals With Oxygen. *Proc. Roy. Soc. Ser. A* 274, 306 (1963).

1417. Battut, R., Berthet, G., Grenier, J., and Imbaud, J. P. Application of the Inverted Overhauser Effect to the Detection of Free Radicals. *Paramagnetic Resonance, Proc. Intern. Conf.*, 1st, Jerusalem, 1962, 2 520 (1963).

1418. Becker, Ralph S., and Wentworth, W. E. Electron Affinities and Ionization Potentials of Aromatic Hydrocarbons. *J. Am. Chem. Soc.* 85, 2210 (1963).

1419. Belova, V. I., Syrkin, Ya. K., and Ikramov, Kh. U. Magnetic Susceptibility of Compounds of Nickel With Nitriles. *Zh. Neorg. Khim.* 9, 1773 (1964).

1420. Berkowitz, J., and Wexler, S. Ionization Potential of the  $\text{CH}_2$  Radical. *J. Chem. Phys.* 37, 1476 (1962).

1421. Billon, Jean Pierre. Electrochemistry of the Oxidation-Reduction Properties of Phenothiazines in Acetonitrile. *Ann. Chim.* 7, 183 (1962).

1422. Brown, Thomas H., and Karplus, Martin. Ion Radicals of Methyl-Substituted Benzenes: Temperature Dependence of Spin and Charge Densities. *J. Chem. Phys.* 39, 1115 (1963).
1423. Burgess, J. H., Rhodes, R. S., Mandel, M., and Edelstein, A. S. Magnetic Susceptibilities and Exchange Effects in Four Organic Free Radicals. *J. Appl. Phys.* 33, Suppl. No. 3, 1352 (1962).
1424. Candela, G. A., and Mundy, R. E. Absolute Magnetic Susceptibilities by the Gouy and Thorpe-Senftle Methods. *IRE Trans. Instr.* 11, 106 (1962).
1425. Cassuto, Albert. An Analysis of the Operation of Cylindrical Reactors in a Heterogeneous System. Application to the Study by Mass Spectrometry of the Methyl and Ethyl Free Radicals. *Ann. Chim.* 7, 249 (1962).
1426. Cauquis, Georges, and Billon, Jean Pierre. Electrochemical Oxidation of Meso-Phenylanthrylamine in Two Steps. Characterization of an Intermediate Ion Radical. *Compt. Rend.* 255, 2128 (1962).
1427. Cauquis, Georges, Billon, Jean Pierre, Raison, Jacques, and Thibaud, Yves. Electrochemical Oxidation of 9-Arylamino-anthracenes in Nonaqueous Medium and (Formation of) Complexes by Charge Transfer. *Ibid.* 257, 2128 (1963).
1428. Chernyakovsky, F. P., Machtina, K. A., and Musabekov, Yu. S. Investigation of the Properties of Crystals of Malachite-Green Group Dyes With Magnetic Methods. *Uch. Zap. Yaroslavsk. Tekhnol. Inst.* 1, 247 (1962).
1429. Dehl, Ronald, and Fraenkel, George K. Electron Spin Resonance (E.S.R.) Spectra of Cyclic Ketals and o-Semiquinones. *J. Chem. Phys.* 39, 1793 (1963).
1430. Earnshaw, A. Magnetochemistry. I. Theory and Applications. *Lab. Pract.* 10, 89 (1961).
1431. Earnshaw, A. Magnetochemistry. II. Construction of a Gouy Balance. *Ibid.*, 157 (1961).
1432. Earnshaw, A. Magnetochemistry. III. The Construction of a Temperature-Variable Gouy Balance. *Ibid.*, 294 (1961).

1433. Eberson, Lennart. Kolbe Electrolytic Synthesis. IV. Theoretical Investigation of the Mechanism by Standard Potential Calculations. *Acta Chem. Scand.* 17, 2004 (1963).

1434. Ebinghaus, H., Kraus, K., Mueller-Duysing, W., and Neuert, H. Negative Ions by Electron Resonance Capture in PH<sub>3</sub>, AsH<sub>3</sub>, and SiH<sub>4</sub>. *Z. Naturforsch.* 19a, 732 (1964).

1435. Eley, D. C., and Willis, M. R. The Electrical Conductivity of Solid Free Radicals and the Electron Tunneling Mechanism. *Symp. Elec. Conductivity Org. Solids*, Durham, N.C., 1960, 257 (1961).

1436. Fioshin, M. Ya., and Kazakova, L. I. The Scheme of Anodic Condensation of Monomethyl Adipate. *Dokl. Akad. Nauk SSSR* 152, 1132 (1963).

1437. Frankevich, E. L., and Yakovlev, B. S. Relaxation Polarization in Saturated Hydrocarbons Irradiated at Low Temperatures. *Zh. Fiz. Khim.* 37, 1106 (1963).

1438. Fristrom, R. M. Scavenger Probe Sampling: A Method for Studying Gaseous Free Radicals. *Science* 140, 297 (1963).

1439. Gaines, A. F., and Page, F. M. Determination of Electron Affinities. VI. Phenyl and Benzyl Radicals. *Trans. Faraday Soc.* 59, 1266 (1963).

1440. Gasanov, F. M., Prokhorov, A. M., and Fedorov, V. B. Paramagnetic Relaxation in Systems With Strong Exchange interaction at Low Temperatures. *Fiz. Tverd. Tela* 6, 193 (1964).

1441. Gavaleshko, N. P. Method of Measuring Magnetic Susceptibility. *Ukr. Fiz. Zh.* 7, 1068 (1962).

1442. Giacometti, G., Nordio, P. L., and Pavan, M. V. Nonneighbor Effects on Hyperfine Coupling Constants in Alternant Hydrocarbon Radicals. *Theoret. Chem. Acta* 1, 404 (1963).

1443. Gibson, J. F. Unpaired Electron in Nitrosobis(dimethyldithiocarbamato)iron(II). *Nature* 196, 64 (1962).

1444. Golovanov, I. B., and Piskunov, A. K. Magnetic Susceptibility of Some Compounds of the Type R-Li and R-O-Li. *Zh. Fiz. Khim.* 38, 2063 (1964).

1445. Gutman, E. E., and Myasnikov, I. A. Effect of the Adsorption of Free Radicals on the Contact Potential of n-Semiconductors. Dokl. Akad. Nauk SSSR 152, 647 (1963).
1446. Harrington, D. B. Experimental Methods for Studying Free Radicals, Using the Time-of-Flight Mass Spectrometer. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 24-1-26 (1961).
1447. Hau, J., Kramer, K., and Mueller-Warmuth, W. Nuclear and Electron Spin Relaxation in Solutions of Aromatic Free Radicals. Proc. Colloq. AMPERE 11, 709 (1962).
1448. Henry, Warren E. Magnetic Interactions of Free Radicals at very Low Temperatures and in Strong Magnetic Fields. Intern. Symp. Free Radical Stabilization, 4th, Washington, D.C., F-V-1-F.V.11 (1959).
1449. Hobrook, Don L., and Kiser, Robert W. Electron Impact Studies of Some Trihalomethanes: Trichloromethane, Dichlorofluoromethane, Chlorodifluoromethane, and Trifluoromethane. J. Phys. Chem. 68, 575 (1964).
1450. Il'yasov, A. V., Garif'yanov, N. S., and Timerov, R. Kh. Nature of the Spin-Lattice Interaction in Magnetically Diluted Free Radicals. Dokl. Akad. Nauk SSSR 150, 588 (1963).
1451. Inokuchi, Hiroo, Shirotani, Ichimin, and Minomura, Shigeru. Electrical Conductivity of  $\alpha, \alpha'$ -Diphenyl- $\beta$ -picrylhydrazyl Under High Pressure. Bull. Chem. Soc. Japan 37, 1234 (1964).
1452. Inoue, Hiroo, and Imoto, Eijii. Electric Conductivities of the Oxidative Condensation Products of Naphthylamine and Naphthylenediamine. Nippon Kagaku Zasshi 83, 1052 (1962).
1453. Iwamoto, Reynold T. Mechanism of Inorganic Reactions: Bridge Mechanism in Electrochemical Oxidation and Reduction of Metal Ions. US Dept. Com., Office Tech. Serv., AD 426,575. 3 pp. 1963.
1454. Jain, Adeshwar Preshad. Spin-Orbit Coupling in the Optical Model From a Study of P-wave Strength Functions. Univ. Microfilms, Order No. 63-2826.

1455. Jones, M. T. Spin-Lattice Relaxation in Some TCNQ (Tetracyanoquinodimethan) Ion-Radical Salts. *J. Chem. Phys.* 40, 1837 (1964).

1456. Kaabak, L. V., Tomilov, A. P., and Varshavskii, S. L. Electroreduction of Unsaturated Nitriles. IV. Electroreduction of 1-Cyano-1,3-butadiene. *Zh. Obshch. Khim.* 34, 2107 (1964).

1457. Karplus, M., and Raff, L. M. Theoretical Investigations of Reactive Collisions in Molecular Beams: K + CH<sub>3</sub>I. *J. Chem. Phys.* 41, 1267 (1964).

1458. Kastening, B. Electrochemical Production, Reactivity, and Properties of the Nitrobenzene Radical Anion. *Electrochem. Acta* 9, 241 (1964).

1459. Kaufman, Joyce J. The Effect of Substitution on the Ionization Potentials of Free Radicals and Molecules. II. Theoretical Interpretation of  $\delta K$  Values for Alkyl Radicals and Amines. *J. Am. Chem. Soc.* 85, 1576 (1963).

1460. Kaufman, Joyce J. The Effect of Substitution on the Ionization Potentials of Free Radicals and Molecules. VII. Theoretical Rationalization for Differing Correlations Found for Bond Dissociation Energies With Ionization Potentials and Electron Affinities of Organic or Inorganic Radicals. *J. Phys. Chem.* 68, 3155 (1964).

1461. Kebarle, P. Free-Radical Reactions by Mass Spectrometry: The Mercury Photosensitized Decomposition of Dimethyl Mercury. *Advan. Mass Spectrometry, Proc. Conf.*, 2nd, Oxford 2, 87 (1961).

1462. Kemula, W., and Sioda, R. Free-Radical Anions of Some Aromatic Nitro Compounds in Dimethylformamide. *Bull. Acad. Polon. Sci., Ser. Sci. Chim.* 11, 395 (1963).

1463. Koyama, Kikuhiro, Odaira, Yoshinobu, and Tsutsumi, Shigeru. Free Radical Reactions by Organic Electrode Processes. I. Acetoxylation of Anisole and Related Compounds. *Technol. Rept. Osaka Univ.* 12, 463 (1962).

1464. Kral, M. The Choice of a Standard in Magneto-chemistry. *Collection Czech. Chem. Commun.* 29, 2841 (1964).

1465. Kudryavtsev, A. S., Savich, I. A., Bylina, E. A., and Spitsyn, V. I. Magnetic Susceptibility of Some Azomethines. *Vestn. Mosk. Univ., Ser. II, Khim.* 18, 32 (1963).

1466. Kuwana, Theodore, and French, William G. Electro-oxidation or Reduction of Organic Compounds in Aqueous Solutions by Using Carbon Paste Electrode. *Anal. Chem.* 36, 241 (1964).

1467. Kuwata, Keiji, and Geske, David H. The Cation Radical of Tetrakis(dimethylamino)ethylene. *J. Am. Chem. Soc.* 86, 2101 (1964).

1468. Kuwata, Keiji, Sato, Yuzuru, and Hirota, Kozo. Electric Conductivity and Electron Spin Resonance of Semiconductive Complexes of Polymer Species of Diphenylamine. *Bull. Chem. Soc. Japan* 37, 1391 (1964).

1469. Lenk, R. Spin Densities in the  $\text{CH}_2\text{-}(\text{CH})_3 = \text{CH}_2$  Radical. *Czech. J. Phys.* 12, 859 (1962).

1470. Lown, J. W. Evidence of Electron-Exchange Between the Triphenylmethyl Radical and Triphenylmethyl Cation in Solution. *Proc. Chem. Soc.*, 283 (1963).

1471. Mackle, K. Thermochemistry of Sulfur-Containing Molecules and Radicals. II. Dissociation Energies of Bonds Involving Sulfur. Heats of Formation of Sulfur-Containing Radicals. *Tetrahedron* 19, 1159 (1963).

1472. Majer, J. R., and Patrick, C. R. Appearance Potentials of the Benzyl Radical-Ion. *Trans. Faraday Soc.* 59, 1274 (1963).

1473. Malone, Creighton Paul. Magnetic Susceptibility Measurements of Single Small Particles. *Univ. Microfilms, Order No. 63=2001.*

1474. Malrieu, Jean Paul, and Pullman, Bernard. Electronic Properties of Phenothiazine and Its Free Radical. *Theoret. Chim. Acta* 2, 293 (1964).

1475. Mangiaracina, R., and Mrozowski, S. Trapped Radicals in Organic Deposits. *Proc. Conf. Carbon*, 5th, Univ. Park, Pa., 2, 89 (1963).

1476. Maricle, D. L. Coulometric Titration of Reducible Organic Compounds With Biphenyl Radical Anions. *Anal. Chem.* 35, 683 (1963).

1477. Martin, T. W., and Rummel, R. E. Mass Spectral Studies of Surface Catalysis. The Production of Free Radicals at 40°. *Science* 143, 797 (1964).

1478. Masuda, Kozo, and Yamaguchi, Jiro. Electric Conduction of  $\alpha, \alpha'$ -Diphenyl- $\beta$ -picrylhydrazyl in Benzene. *J. Phys. Soc. Japan* 19, 1190 (1964).

1479. Masuda, Kozo, Gamo, Kenji, Nishijima, Mitsuaki, and Yamaguchi, Jiro. Electric Conduction of  $\alpha, \alpha'$ -Diphenyl- $\beta$ -picrylhydrazyl (DPPH) in Benzene. *Technol. Rept. Osaka Univ.* 14, 507 (1964).

1480. Morokuma, Keiji, Yonezawa, Teijiro, and Fukui, Kenichi. Simple Molecular Orbital Method for Discussing the Electronic Structures of Stereoisomers - the Theoretical Method and the Electron Spin Resonance Hyperfine Splittings of the Terephthalaldehyde Anion. *Bull. Chem. Soc. Japan* 35, 1646 (1962).

1481. Moryganov, B. N., Kalinin, A. I., and Mikhovova, L. N. Thermal Decomposition of Acetone Diperoxide in Organic Solvents Studied by the Polarographic Method. *Zh. Obshch. Khim.* 32, 3476 (1962).

1482. Mulay, L. N. Magnetic Susceptibility and Resonance Studies on Adsorption. *Offic. Dig., Paint Technol. Eng.* 36, 572 (1964).

1483. Myasnikov, I. A., Bol'shun, E. V., and Gutman, E. E. Mechanism of Adsorption of Radicals on Semiconductors and the Phenomena of Desorption of Radicals From Hot Walls. *Kinetika i Kataliz* 4, 867 (1963).

1484. Ogawa, Seiji, and Fessenden, Richard W. Ring Inversion in Cyclohexyl Radical. *J. Chem. Phys.* 41, 994 (1964).

1485. Palmer, Howard B., and Miller, William J. Energy Distribution in Products of the Reaction of C Atoms With CH and CCl. *Ibid.* 38, 278 (1963).

1486. Palmer, T. F., and Lossing, F. P. Free Radicals by Mass Spectrometry. XXX. Ionization Potentials of Anilino and 2-, 3-, and 4-Pyridylmethyl Radicals. *J. Am. Chem. Soc.* 85, 1733 (1963).

1487. Palmer, T. F., and Loessing, F. P. Free Radicals by Mass Spectrometry. XXXI. H-Atom and D-Atom Removal in the Mercury-Photosensitized Decomposition of Isobutane and Deuterioisobutanes. *Can. J. Chem.* 41, 4212 (1963).

1488. Pannetier, Guy, Maresigny, Louis, and Bremond, Muryel. CN Radical Rotation. Measurement of the Relative Temperatures of Rotation of CN ( $^2\Sigma_u^+ - ^2\Sigma_g^+$ ) in the Electrical Discharge of Acetonitrile. Double Origin of This Radical. *J. Chim. Phys.* 59, 1192 (1962).

1489. Papulov, Yu. G. Energies of Homolytic and Heterolytic Bond Cleavage in X-Substituted Methane. *Zh. Obshch. Khim.* 34, 1252 (1964).

1490. Peover, M. E. Reduction Potentials and Intermolecular Charge-Transfer Spectra of Organic Acceptor Molecules. II. Anhydrides and Cyanohydrocarbons. *Trans. Faraday Soc.* 58, 2370 (1962).

1491. Price, W. C., Harris, P. V., and Passmore, T. R. The Ionization and Dissociation Energies of Molecules and Radicals. *J. Quant. Spectry. Radiative Transfer* 2, 327 (1962).

1492. Prokhorov, A. M., and Fedorov, V. B. Antiferromagnetism of Free Radicals. *Zh. Ekspерим. i Teор. Fiz.* 43, 2105 (1962).

1493. Richards, R. E., and White, J. W. Relative Couplings Between Free Radicals and H and F Nuclei by the Overhauser Effect. *Proc. Chem. Soc.* 119 (1962).

1494. Rieger, Philip Henri. An Electron Spin Resonance Study of Electrolytically Generated Free Radicals. Univ. Microfilms, Order No. 63-1517.

1495. Rieger, Philip H., Bernal, Ivan, Reimnuth, William H., and Fraenkel, George K. Electron Spin Resonance of Electrolytically Generated Nitrile Radicals. *J. Am. Chem. Soc.* 85, 683 (1963).

1496. Slinkin, A. A., Fedorovskaya, E. A., and Rubinstein, A. M. Electron Paramagnetic Resonance (E.P.R.) Spectra and the Magnetic Susceptibility of Aluminum-Chromium Catalysts. *Kinetika i Kataliz* 4, 230 (1963).

1497. Smith, Henry Michael. A Study of the Magnetochemistry of Some Complex Compounds and the Construction of a Cryostat for Low-Temperature Susceptibility Measurements. Univ. Microfilms, Order No. 63-3523.

1498. Sohma, Junkichi. Effect of Lifetime of Free Radicals in Chemical Reaction on ESR (Electron Spin Resonance) Relaxation. J. Chem. Phys., 37, 2151 (1962).

1499. Stone, A. J. Tensors of Aromatic Hydrocarbons. Mol. Phys., 7, 311 (1963-1964).

1500. Suchet, J., Rodot, H., Leroux-Hugon, P., and Rodot, M. Propagation of Electrons and Phonons. Application to the Study of Thermoelectric Materials. Advan. Energy Conversion 3, 569 (1963).

1501. Sunahara, Hiroshi. Brdicka's Catalytic Hydrogen Wave. I. The Reduction Waves of Cobalt Concerning the Brdicka's Catalytic Hydrogen Wave. Rev. Polarog., 2, 158 (1961).

1502. Sunahara, Hiroshi. Brdicka's Catalytic Hydrogen Wave. II. Polarography of  $\alpha$ -Lipoic Acid in Co(II) or Co(III)-Ammoniacal Ammonium Chloride Solution. Ibid., 165 (1961).

1503. Sunahara, Hiroshi. Brdicka's Catalytic Hydrogen Wave. III. Polarography of Cystine in the Solution of Ammoniacal Ammonium Chloride Containing Hexamminecobalt(III) Chloride. Ibid., 222 (1961).

1504. Sunahara, Hiroshi. Brdicka's Catalytic Hydrogen Wave. IV. The Role of Amino and Carboxyl Groups on the Catalytic Hydrogen Waves. Ibid., 233 (1961).

1505. Tirouflet, Jean, Dabard, Rene, and Laviron, Etienne. Studies in Metallocene Series. III. Polarography of Functional Groups in (Substituted) Ferrocenes and Cyclopentadienylmanganese Tricarbonyls. Bull. Soc. Chim. France, 1655 (1963).

1506. Tollin, Gordon. Electrical and Magnetic Properties of Organic Solids. NASA Doc. N63-12731 (1962).

1507. van den Bosch, A. The Magnetic Susceptibility of Single Crystals of Lithium Fluoride Irradiated by Thermal Neutrons. J. Phys., 24, 569 (1963).

1508. van Itterbeek, A., and Labro, M. Static Magnetic Susceptibility of DPPH (2,2'-Diphenyl-1-picrylhydrazyl) Between 294 and 1.2°K. Physica 30, 157 (1964).

1509. Ward, George A., and Wright, Charles M. The Electrochemistry of Inorganic Difluoroamino Compounds. I. The Mechanism of the Electrochemical Oxidation of Difluoroamine and the Use of this Reaction in the Synthesis of Alkyl Difluoroamines. J. Am. Chem. Soc. 86, 4333 (1964).

1510. Witkowski, Andrzej. Coupling of Charge Transfer With Nuclear Motion in Aromatic Free Radicals. Compt. Rend. 256, 419 (1963).

#### GENERAL CONSIDERATIONS.

1511. Albers, Robert J. Geometry of a Free Radical. Univ. Microfilms, Order No. 64-3517.

1512. Alfimov, M. V., Nikol'skil, V. G., and Buben, N. Ya. Thermoluminescence and Electron Paramagnetic Resonance (E.P.R.) Spectra of Organic Compounds Irradiated With Fast Electrons. Kinetika i Kataliz 5, 268 (1964).

1513. Anderson, Per, and Klewe, Bernt. Structure Investigation of the Free Radical Tris-(*p*-nitrophenyl)methyl. Acta Chem. Scand. 16, 1817 (1962).

1514. Antonowicz, K. Formation by Chemical Attack and Nature of Spin Centers in Carbon. Proc. Conf. Carbon, 5th, Univ. Park, Pa. 1, 56 (1962).

1515. Appelbaum, Arthur. Studies in Free-Radical Chemistry. Univ. Microfilms, Order No. 63-2345.

1516. Asahara, Teruzo, Takagi, Yukio, and Nagai, Makoto. Telomerization of Ethylene With  $\alpha$ , $\omega$ , $\omega$ -Trichloro- $\omega$ -iodoalkane. Bull. Japan. Petrol. Inst. 5, 36 (1963).

1517. Assour, J. M., and Harrison, S. E. Origin of Unpaired Electrons in Metal-Free Phthalocyanine. J. Phys. Chem. 68, 872 (1964).

1518. Atherton, N. M., and Goggins, A. E. Association Between Pyrazine Anions and Sodium Ions. *Mol. Phys.* 8, 99 (1964).

1519. Atherton, N. M., Gerson, F., and Murrell, J. N. Electron Spin Distribution in the Cycl(3,2,2)azine Anion. *Ibid.* 6, 265 (1963).

1520. Balaban, A. T., Bratu, C., and Rentea, C. N. One-Electron Reduction of Pyrylium Salts. *Tetrahedron* 20, 265 (1964).

1521. Barachevskii, V. A., Kholmogorov, V. E., and Terenin, A. N. The Concentration Effect in Absorption and Electron Paramagnetic Resonance (E.P.R.) Spectra of Adsorbed Molecular Ions of Anthracene. *Dokl. Akad. Nauk SSSR* 152, 1143 (1963).

1522. Benson, Sidney W. Kinetics of Pyrolysis of Alkyl Hydroperoxides and Their O-O Bond Dissociation Energies. *J. Chem. Phys.* 40, 1007 (1964).

1523. Benson, Sidney W. Some Problems of Structure and Reactivity in Free Radical and Molecule Reactions in the Gas Phase. *Advan. Photochem.* 2, 1 (1964).

1524. Bernstein, H. J. H Atom Adducts - New Free Radicals? *J. Am. Chem. Soc.* 85, 484 (1963).

1525. Bielski, B.H.J., and Saito, Eichi. Activation Energy for the Disproportionation of the HO<sub>2</sub> Radical in Acid Solutions. *J. Phys. Chem.* 66, 2266 (1962).

1526. Bishop, D. M. Stability of the Ammonium Radical (NH<sub>4</sub>). *J. Chem. Phys.* 40, 432 (1964).

1527. Bishop, E. Induction of Electron-Transfer Reactions. *Acta Chim. Acad. Sci. Hung.* 35, 273 (1963).

1528. Blyumenfel'd, L. A., Voevodskii, V. V., and Solodownikov, S. P. The Nature of Ion-Radicals Formed in the Reaction of Potassium and Sodium With Some Aromatic Hydrocarbons. *Izv. Akad. Nauk SSSR, Ser. Khim.*, 158 (1964).

1529. Boocock, J. R. B., and Hickinbottom, W. J. The Synthesis and Reactions of Branched-Chain Hydrocarbons. XV. Free-Radical Chlorination in the Liquid Phase. *J. Chem. Soc.*, 1234 (1963).

1530. Borg, D. C. Improved Flow System for Electron Paramagnetic Resonance Spectrometry of Aqueous Solutions. *Nature* 201, 1087 (1964).

1531. Boyd, R. K., Downs, G. W., Gow, J. S., and Horrex, C. Hydrogen Iodide as Radial Acceptor in the Thermal Decomposition of Gaseous Organic Iodides. *J. Phys. Chem.* 67, 719 (1963).

1532. Brown, Thomas H., Karphis, Martin, and Schug, John C. Spin Resonance Spectra of Substituted Aromatic Ions: Turbation Model. *J. Chem. Phys.* 38, 1749 (1963).

1533. Brubaker, Carl H., Jr. The Mechanisms of Oxidation-Reduction Reactions in Solutions. *Record Chem. Progr.* 24, 181 (1963).

1534. Carter, James Horace, Jr. Thermal, Photolytic, and Acid-Catalyzed Decomposition of Phenyl Azides. Univ. Microfilms, Order No. 63-4943.

1535. Chamboux, Jeannine, and Lucquin, Michel. Low Temperature Combustion of Acetaldehyde. II. Application of the Theory of Branched-Chain Reactions. *J. Chim. Phys.* 60, 521 (1963).

1536. Chamboux, Jeannine, and Lucquin, Michel. Low Temperature Combustion of Acetaldehyde. III. Study of the Initiation Reaction. *Ibid.*, 527 (1963).

1537. Chandross, Edwin A. A New Chemiluminescent System. *Tetrahedron Letters*, 761 (1963).

1538. Cheng, Chih-Feng. Chemistry of Ion-Radicals. *Hua Hsueh T'ung Pao*, 16, 56 (1964).

1539. Ciranni, Elena, Ciranni, Giovanna, and Guarino, Angelo. Labeling Aromatic Hydrocarbons by Tritium Atoms Produced by the  $\text{Li}^6(n, \alpha)\text{H}^3$  Reaction. *Gazz. Chim. Ital.* 93, 610 (1963).

1540. Clar, Erich, Macpherson, Ian A., and Schulz-Kiesow, Hans. Significance of Kekule Structures for the Stability of Aromatic Systems. III. Benzozethrene and Dibenzozethrene Derivatives. Ann 669, 44 (1963).

1541. Cohen, Fredrick Sumner. Free Radical Decomposition and Dissociation of Some Derivatives of Triphenylmethane. Univ. Microfilms, Order No. 64-3068.

1542. Cohen, Saul G., Cohen, Fredric, and Wang, Chi-Hua. Comparison of 9-Phenylfluorenyl and Triphenylmethyl in the Decomposition of Azo Compounds. J. Org. Chem. 28, 1479 (1963).

1543. Colburn, Charles B., Ettinger, Raymond, and Johnson, Frederick A. Isolation and Storage of Free Radicals on Molecular Sieves. I. The Electron Paramagnetic Resonance (E.P.R.) Spectrum of Nitrogen Dioxide. Inorg. Chem. 2, 1305 (1963).

1544. Dachauer, Andrew Conrad. The Deuterium Isotope Rate Effect in Free-Radical Reactions of Tertiary Carbon Deuterated DDT and Its Analogs. Univ. Microfilms, Order No. 62-3762.

1545. de Boer, E., and Mackor, E. L. Sign of C<sup>13</sup> Coupling Constants in Aromatic Free Radicals. J. Chem. Phys. 38 1450 (1963).

1546. de Maeyer, Leo, and Kustin, Kenneth. Fast Reactions in Solution. Ann. Rev. Phys. Chem. 14, 5 (1963).

1547. Denisov, E. T., and Kharitonov, V. V. Mechanism of Inhibition of Oxidation of Cyclohexanol by  $\alpha$ -Naphthol. Zh. Fiz. Khim. 38, 639 (1964).

1548. Diebler, H. Kinetic Investigation of the Reversible Reduction-Oxidation Reaction of (Fe(CN)<sub>6</sub>)<sup>4-</sup> With Dichloroindophenol. Ber. Bunsenges. Physik. Chem. 67, 396 (1963).

1549. Dixon-Lewis, G., and Williams, A. Methods for Investigating Free-Radical Reactions in a H<sub>2</sub>O<sub>2</sub> Flame in the Region of 1000°K. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 1-11 (1961).

1550. Donnet, J. B., and Netzger, J. The Kinetics of Free Radical Attachment to the Surface of Carbon Black. Colloq. Nationaux Centre Natl. Rech. Sci. No. 24, 67 (1963).

1551. Edelstein, Alan Shane. Cooperative Effects in Four Organic Free Radicals. Univ. Microfilms, Order No. 64-1606.

1552. Elofson, R. M., Anderson, D. H., Gutowsky, H. S., Sandin, R. B., and Schulz, K. F. Some Reactions of Solid Tetrakis(p-(dimethylamino)phenyl)ethylene Diiodide Monohydrate. J. Am. Chem. Soc., 85, 2622 (1963).

1553. Errede, L. A., and Cassidy, J. P. Xylylenes. XVI. The Trapping of Radicals in Gas Streams by Mutual Quench Techniques. J. Phys. Chem., 66, 69 (1962).

1554. Errede, L. A., and Cassidy, J. P. Xylylenes. XVII. The Mechanism for Formation of Xylylenes in Gas Phase. Ibid., 73 (1962).

1555. Errede, L. A., and DeMaria, F. Xylylenes. XV. The Kinetics of Fast Flow Pyrolysis of p-Xylene. Ibid., 2664 (1962).

1556. Esteban, G. L., Kerr, J. A., and Trotman-Dickenson. Pyrolysis of Ethyl-, Propyl-, and Butylbenzene and the Heats of Formation of the Benzyl and Propyl Radicals. J. Chem. Soc., 3873 (1963).

1557. Eusuf, M., and Laidler, K. J. Theoretical Aspects of Atom and Radical Combination Reactions. Trans. Faraday Soc., 59, 2750 (1963).

1558. Factor, Arnold. The Reaction of Styrene, Iodine and Oxygen. Univ. Microfilms, Order No. 63-7833.

1559. Feher, G. Review of Electron Spin Resonance Experiments in Semi-Conductors. Paramagnetic Resonance, Proc. Intern. Conf., 1st, Jerusalem, 1962, 2, 715 (1963).

1560. Fisher, I. P., and Lossing, F. P. Ionization Potential of Benzyne. J. Am. Chem. Soc., 85, 1018 (1963).

1561. Foner, S. N. Free Radicals and Unstable Molecules. Science 143 441 (1964).

1562. Fristrom, R. M. Radical Concentrations and Reactions in a Methane-Oxygen Flame. Symp. Comb., 9th, Cornell Univ., Ithaca, N. Y., 560 (1962).

1563. Gaillard-Cusin, Françoise, and James, Henri. Influence of Hydroxyl Radicals on the Kinetics of the Combustion of Carbon Monoxide. *J. Chim. Phys.* 61, 363 (1964).
1564. Glarum, Sivert H. Spin-Orbit Interactions in Molecular Radicals. *J. Chem. Phys.* 39, 3141 (1963).
1565. Gleicher, Gerald Jay. The Role of  $\pi$ -Complexes in the Reactions of the Trichloromethyl Radical. Univ. Microfilms, Order No. 64-816.
1566. Goldberg, Paul. Free Radicals and Reactive Molecules in Clathrate Cavities. *Science* 142, 378 (1963).
1567. Goldberg, Paul. Stabilization of Free Radicals and Reactive Molecules in Cavities of the Water Clathrate Lattice. *J. Chem. Phys.* 40, 427 (1964).
1568. Goldberg, P. Qualitative Test for the Presence of Paramagnetic Species. *J. Chem. Educ.* 41, 450 (1964).
1569. Gousselard, G. The Spatial Distribution of Electrons Around an Impurity in the Nearly Free Electron Approximation. Application to Direct Coupling Between Nuclear Spins Through Conduction Electrons. *J. Phys. Radium* 23, 928 (1962).
1570. Hansen, Richard L., and Hamann, Roland R. Origin of Free Radicals in the Oxidation of Trialkylborons. *J. Phys. Chem.* 67, 2868 (1963).
1571. Hart, Edwin J., Gordon, Sheffield, and Thomas, J. K. Rate Constants of Hydrated Electron Reactions With Organic Compounds. *Ibid.* 68, 1271 (1964).
1572. Harteck, Paul, and Reeves, Robert R. Chemiluminescent Reactions of Major Importance For the Upper Atmosphere. *Bull. Soc. Chim. Belges* 71, 682 (1962).
1573. Hartley, D. B., and Benson, Sidney W. Kinetics of the Reaction of HI With Ethyl Iodide and the Heat of Formation of the Ethyl Radical. *J. Chem. Phys.* 39, 132 (1963).

1574. Hartmann, H., Gliemann, G., and Gebler, H. The Theory of Parahydrogen Transformation by Biradicals. *Theoret. Chim. Acta* 1, 144 (1963).

1575. Herzberg, G. Determination of the Structures of Simple Polyatomic Molecules and Radicals in Electronically Excited States. Twelfth Spiers Memorial Lecture. *Discussions Faraday Soc.*, 7 (1963).

1576. Heusler, K., and Kalvoda, J. Intramolecular Radical Reactions. *Angew. Chem.* 76, 518 (1964).

1577. Hochstrasser, Robin M. The Luminescence of Organic Molecular Crystals. *Rev. Mod. Phys.* 34, 531 (1962).

1578. Holland, B. W. The One-Electron States of Imperfect Crystals. *Phil. Mag.* 8, 87 (1963).

1579. Hutchison, Clyde, A., Jr. Paramagnetic Resonance of Phosphorescent Organic Molecules. *Record Chem. Progr.* 24, 105 (1963).

1580. Huyser, Earl S., and Neckers, Douglas C. Dialkyl Peroxide-Induced Reductions of Aromatic Ketones. *J. Am. Chem. Soc.* 85, 3641 (1963).

1581. Imamura, Tosiaki. Color Reagents of the Dipyridyl Series. *Kagaku* 17, 424 (1962).

1582. Imoto, Eizi, and Otsuji, Yoshio. Nitrogen Radicals and Ions as Intermediates in Organic Reactions. *Yuki Gosei Kagaku Kyokai Shi* 22, 189 (1964).

1583. Ivanov, Chir., and Márkov, P. Reduction of Organic Compounds With Mg or Zn in Liquid Ammonia. *Compt. Rend. Acad. Bulgare Sci.* 15, No. 1, 49 (1962).

1584. Jagur, J., Monteiro, H., and Dzwarc, M. Chemistry of Radical Ions. II. Alternative Method for Determining the Equilibrium Constant of Dissociation. *Trans. Faraday Soc.* 59, 1353 (1963).

1585. Janzen, Edward George. Autoxidation of Carbanions. Occurrence of Electron-Transfer Reactions. Univ. Microfilms, Order No. 64-3792.

1586. Jemia, Hassine Ben., and Lefebvre, Roland. Calculation of the Spin Densities of Aromatic Radicals. *J. Chim. Phys.* 59, 754 (1962).

1587. Julia, Marc, and Le Goffic, Francois. Radical Cyclizations. V. Synthesis of Tricyclic Compounds by Radical Cyclization. *Bull. Soc. Chim. France*, 1129 (1964).

1588. Julia, Marc, Le Goffic, Francois, and Katz, Lazare. Radical Cyclizations. IV. Synthesis of a Decalin Derivative by Radical Dicyclization of an Aliphatic Cyanodiene Ester. Stereochemistry of the Addition of Ethyl Cyanoacetate to Methylcyclohexene. *Ibid.*, 1122 (1964).

1589. Julia, Marc, Surzur, Jean Marie, and Katz, Lazare. Radical Cyclizations. II. Cyclization of  $\alpha$ -Cyano- $\epsilon$ -ethylenic Esters of Cyclohexyl or Cyclopentyl Esters. *Ibid.*, 1109 (1964).

1590. Julia, Marc, Surzur, Jean Marie, Katz, Lazare, and Le Goffic, Francois. Radical Cyclizations. III. Formation of a Decalin System. *Ibid.*, 1116 (1964).

1591. Julia, Marc, Surzur, Jean Marie, Katz, Lazare, Le Goffic, Francois, and James, Claude. Radical Cyclizations. I. Introduction. *Ibid.*, 1106 (1964).

1592. Karpukhin, O. N., Rusina, I. F., Nikiforov, G. A., and Shlyapintokh, V. Ya. Spatially-Hindered Phenolphthaleins and the Possibility of Using Them for Study of Inhibited Oxidation Processes. *Neftekhimiya* 3, 579 (1963).

1593. Karpukhin, O. N., Shlyapintokh, V. Ya., Rusina, I. F., and Zolotova, N. V. Chemiluminescent Method for the Determination of Inhibitors in Free Radical Reactions. *Zh. Analit. Khim.* 18, 1021 (1963).

1594. Kerr, J. A., Sekhar, R. C., and Trotman-Dickenson, A. F. Pyrolyses of Hydrazines and Benzylamines. C-C and N-N Bond Dissociation Energies. *J. Chem. Soc.*, 3217 (1963).

1595. Kharitonenkov, I. G., Kalmanson, A. E., Chetverikov, A. G., and Blyumenfel'd, L. A. Study by the Jet-Stream Method of the Origin and Destruction of Free Radicals of the Semiquinone Type in Systems Modeling Biological Oxidation. *Biofizika* 9, 172 (1964).

1596. Kinoshita, Minoru. The Exchange Interaction Between Different Electron Spins in Organic Molecular Complexes. Bull. Chem. Soc. Japan 36, 307 (1963).

1597. Kohlmaier, G. H., and Rabinovitch, B. S. Collisional Transition Probabilities for Vibrational Deactivation of Chemically Activated sec-Butyl Radicals. Diatomic and Polyatomic Molecules. J. Chem. Phys. 38, 1709 (1963).

1598. Kohlmaier, G. H., and Rabinovitch, B. S. Collisional Transition Probabilities for Vibrational Deactivation of Chemically Activated sec-Butyl Radicals. The Rare Gases. Ibid., 1692 (1963).

1599. Koshkin, L. V., and Musabekov, Yu. S. The Evolution of Study of Biradicals. Khim. i Khim. Tekhnol., Yaroslavsk. Tekhnol. Inst. 1, 263 (1962).

1600. Koshkin, L. V., and Musabekov, Yu. S. Theory of the Stability of Free Radicals. Uch. Zap. Yaroslavsk. Tekhnol. Inst. 6, 197 (1961).

1601. Krause, A. Metal Oxide Catalysis on  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> for Dehydrogenating Reactions. Bull. Acad. Polon. Sci., Ser. Sci. Chim. 8, 201 (1960).

1602. Kuentzel, L. E. Investigation of Activated Species. NASA, Doc. N62-17, 169 (1962).

1603. Kuroda, H., Yoshihara, K., Kinoshita, M., and Akamatu, H. The Charge-Transfer Interaction in Solid Molecular Complexes. Proc. Intern. Symp. Mol. Struct. Spectry., Tokyo (1962).

1604. Laffitte, P., Cusin, F., and James, H. Influence of Hydroxyl Radicals on the Kinetics of the Combustion Reaction of Carbon Monoxide. Combust. Flame 7, No. 1, 101 (1963).

1605. Lagercrantz, Carl, and Yhland, Margareta. Free Radicals in Some Reactions of Ninhydrin. Acta Chem. Scand. 17, 277 (1963).

1606. Laidler, K. J., Sagert, N. H., and Wojciechowski, B. W. Kinetics and Mechanisms of the Thermal Decomposition of Propane. I. The Uninhibited Reaction. *Proc. Royal Soc. Ser. A* 270, 242 (1962).
1607. Laidler, K. J., Sagert, N. H., and Wojciechowski, B. W. Kinetics and Mechanisms of the Thermal Decomposition of Propane. II. The Reaction Inhibited by Nitric Oxide. *Ibid.*, 254 (1962).
1608. Lavin, George I., Coates, Arthur D., and Rakaczky, John A. Free Radicals Bibliography and Survey of Publications (up to 1959). US Dept. Com., Office Tech. Serv., AD 266, 806. 400 pp. 1961.
1609. Levison, Stuart Allan. Kinetic Investigations of Electron Transfers in Aqueous Solution. Univ. Microfilms, Order No. 62-5629.
1610. Lieber, Eugene. Investigations Concerning the Possible Existence of N, N<sub>2</sub>, and N<sub>3</sub> Radicals. US Dept. Com., Office Tech. Serv., PB Rept. 156, 460. 68 pp. 1962.
1611. Linnell, Robert H. The Thermal Decomposition of Pyridine. *Tobacco Sci.* 6, 104 (1962).
1612. McClelland, B. J. Anionic Free Radicals. *Chem. Rev.* 64, 301 (1964).
1613. McGee, Henry A., Jr. Trapped Species and Chemical Synthesis at Cryogenic Temperatures. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, A2-1-43 (1961).
1614. Mal'tsev, Yu. A., Skorokhodov, I. I., and Nekrasov, L. I. Higher Hydrogen Peroxides and Frozen Radicals. VII. Electron Diffraction Studies of Peroxide-Radical Condensates. *Zh. Fiz. Khim.* 37, 2740 (1963).
1615. Martin, J. C., and Smith, Russell G. Factors Influencing the Basicities of Triarylcuinbinols. The Synthesis of Sesquixanthydrol. *J. Am. Chem. Soc.* 86, 2252 (1964).
1616. Martin, J. C., Tuleen, David, Drew, Ernest, Koenig, Thomas, and Fisher, Thomas. The Effect of Molecular Structure on the Cleavage of Oxygen-Oxygen Bonds. *US Govt. Res. Rept.* 39, 21 (1964).
1617. Meleshina, A. M., and Zalukaev, L. P. Formation of complexes With Charge Transfer by Free Radicals. *Zh. Fiz. Khim.* 38, 1434 (1964).

1618. Merrifield, R. E. Excition Impurity Levels in Molecular Crystals. *J. Chem. Phys.* 38, 920 (1963).

1619. Migita, Toshihiko, Ito, Ryiochi, and Tokumaru, Matsumi. Recent Advances in Chemistry of Free Radicals. *Yuki Gosei Kagaku Kyokai Shi* 22, 241 (1964).

1620. Mein, F. B. Calculation of the Activation Energy of Radical Reactions on the Additivity Principle. *Dokl. Akad. Nauk SSSR* 152, 1169 (1963).

1621. Moran, James Paul, Jr. Polar Effects on the Rates of Formation and Dimerization of Free Radicals From Ethyl Acetate. Univ. Microfilms, Order No. 64-3549.

1622. Nangia, Prakash S., and Benson, Sidney W. The Kinetics of Dehydrogenation of Propane by Iodine Vapor and the Heat of Formation of the Isopropyl Radical. *J. Am. Chem. Soc.* 86, 2773 (1964).

1623. Neale, Robert S., and Hinman, Richard L. The Chemistry of Ion Radicals. The Free Radical Addition of N-chlorodialkylamines to Butadiene. *Ibid.* 85, 2666 (1963).

1624. Neiman, M. G., Efremov, V. Ya., and Serdyuk, N. K. Kinetic Tracer Investigations on Competing Reactions Involving Certain Radicals. *Intern. J. Appl. Radiation Isotopes* 13, 295 (1962).

1625. Nielsen, Arnold T., Moore, Donald W., Muha, George M., and Berry, Kristin Highberg. 1,1'-Diacetyl-1,1'-dihydro-4,4'-bipyridine and the Yellow and Colorless Modifications of 1,1'-Diacetyl-1,1',4,4'-tetrahydro-4,4'-bipyridine. The 1,1'-Diacetyl-4,4'-bipyridine Radical Cation. *J. Org. Chem.* 29, 2175 (1964).

1626. Nikiforov, G. A., and Dyumaev, K. M. Inhibitors of Free Radical Reactions. IV. Synthesis of 3,5-Dialkyl-4-hydroxyphenylethylamines. *Izv. Akad. Nauk SSSR, Otd. Khim. Nauk*, 721 (1963).

1627. Nikiforov, G. A., Dyumaev, K. M., Volod'kin, A. A., and Ershov, V. V. Inhibitors of Free Radical Reactions. III. Formylation of 2,6-Dialkylphenols. *Ibid.*, 1836 (1962).

1628. Orbach, R. Thermal Resistance of Kramers Salts. *Phys. Letters* 3, 269 (1963).
1629. Orlando, Charles M., Jr., and Weiss, Karl. Chemistry of Cycloheptatriene. III. Carbon-Carbon Bond Formation in Catalytic Hydrogenolysis: Difference in Behavior of Adsorbed Isomeric C<sub>7</sub>H<sub>7</sub> Radicals. *J. Org. Chem.* 27, 4714 (1962).
1630. Papulov, Yu. G. The Properties and Reactivity of X-Substituted Methanes in Relation to Their Structure. *Zh. Strukt. Khim.* 4, 617 (1963).
1631. Patmore, Edwin Lee. Some Free Radical Reactions of Coordinated Ligands. Univ. Microfilms, Order No. 64-3553.
1632. Pocker, Y. Wagner-Meerwein and Pinacolic Rearrangements in Acyclic and Cyclic Systems. *Mol. Rearrangements* 1, 1 (1963).
1633. Prakash, Satya, Pandey, Jata Dhari, and Ichhaporia, Firoze Maneckji. Effect of Concentration, Bulk, and Intensity on the Sono-Chemical Decomposition of Tetrachloroethane. *Indian J. Chem.* 2, 76 (1954).
1634. Radich, L., and Mardaleishvili, R. E. Isotope Exchange of Free Radicals and Deuterium. *Dokl. Akad. Nauk SSSR* 146, 618 (1962).
1635. Raley, John H., Mullineaux, Richard D., and Bittner, Clarence W. High Temperature Reactions of Iodine With Hydrocarbons. I. Dehydrogenation. *J. Am. Chem. Soc.* 85, 3174 (1963).
1636. Razuvayev, G. A. Homolytic Decomposition Reactions of Organometallic Compounds. *Tr. po Khim. i Khim. Tekhnol.*, 278 (1963).
1637. Razuvayev, G. A. The Principal Trends in Investigations of Organic Peroxide Compounds. *Khim. Perekisnykh Soedin.*, Akad. Nauk SSSR, Inst. Obshch. i Neorgan. Khim., 198 (1963).
1638. Razuvayev, G. A., and Zateev, B. G. Thermal Decomposition of Benzoyl Peroxide in Phenylcyclohexane. *Zh Obshch. Khim.* 33, 673 (1963).

1639. Reynolds, Warren L. Rate of Electron Exchange Between 2,2'-Bipyridine and 2,2'-Bipyridine Negative Ion. *J. Phys. Chem.* 67, 2866 (1963).
1640. Schaastnev, P. V., and Zhidomirov, G. M. The Semiempirical Theory of Isotropic Hyperfine Splitting in the Electron Spin Resonance Spectra of Free Radicals. *Dokl. Akad. Nauk SSSR* 153, 151 (1963).
1641. Schrader, D.M., and Karplus, M. Orbital Following in the Methyl Radical. *J. Chem. Phys.* 40, 1593 (1964).
1642. Scott, George P., and Wang, James C. Telomerization by Free Radical Mercaptan Chain Transfer. I. Styrene and Ethane-thiol. *J. Org. Chem.* 28, 1314 (1963).
1643. Seki, Shuzo. Catching Free Radicals at Low Temperatures. *Kagaku* 18, 476 (1963).
1644. Sharpatyi, V. A., Safarov, S. A., and Yanova, K. G. Radiational and Chemical Stability of Some Heterocyclic Compounds. *Dokl. Akad. Nauk SSSR* 147, 863 (1962).
1645. Shine, H. J., and Robinson, T. A. Ion-Radicals. III. Isolation of a Hydroxythianthrene Oxide From Thianthrene Monoxide in Concentrated Sulfuric Acid. *J. Org. Chem.* 28, 2828 (1963).
1646. Slaugh, Lynn H., Mullineaux, Richard D., and Raley, John H. High Temperature Reactions of Iodine With Hydrocarbons. III. Rearrangement of Aliphatic Free Radicals. *J. Am. Chem. Soc.* 85, 3180 (1963).
1647. Smith, David Young. A Variational Theory of Paramagnetic Impurities in van der Waals Crystals. Univ. Microfilms, Order No. 62-6654.
1648. Spach, G., Monteiro, H., Levy, M., and Szwarc, M. Chemistry of Radical-Ions. Exchange Between Diphenylethylene and Its Dimeric-Dinegative Ions. *Trans. Faraday Soc.* 58, 1809 (1962).
1649. Stamires, Dennis N., and Turkevich, John. Electron Spin Resonance of Molecules Adsorbed on Synthetic Zeolites. *J. Am. Chem. Soc.* 86, 749 (1964).

1650. Stone, A. J. Factors of Aromatic Free Radicals. *Mol. Phys.* 6, 509 (1963).
1651. Strom, Edwin Thomas. Electron-Transfer Reactions of Organic Compounds. Univ. Microfilms, Order No. 64-9287.
1652. Szwarc, M. The Transition State in Radical Reactions. *Chem. Soc. Spec. Publ.* No. 16, 91 (1962).
1653. Takehisa, Masaaki, Yasumoto, Masahiko, and Hosaka, Yoshinobu. Telomerization by Radiation. III. Telomerization of Ethylene With  $\text{CCl}_4$  Induced by Gamma-Radiation Under a Constant Ethylene Pressure. *Kogyo Kagaku Zasshi* 66, 259 (1963).
1654. Tanaka, Masaru, Teuzukida, Yasuharu, and Satake, Kazuo. Intermolecular Transfer of the 2,4,6-Trinitrophenyl Group Bound to Amino Radicals. *Nippon Kagaku Zasshi* 83, 895 (1962).
1655. Tanaka, Toyosuke. The Free Radical Reactions of Acyl Peroxides With Special Reference to Russian Progress. *Kagaku No Ryoiki* 17, 760 (1963).
1656. Thomas, J. R. Stability of Cumyloperoxy Radical-Pyridine Charge-Transfer Complex. *J. Am. Chem. Soc.* 85, 591 (1963).
1657. Tokumaru, Katsumi. Mechanism of Reactions of Peroxides With Various Reagents. *Yuki Gosei Kagaku Kyokai Shi* 21, 164 (1963).
1658. Topchiev, A. V., Balod, A. P., Fedorova, T. V., and Shtern, V. Ya. The Mechanism of Vapor-Phase Interactions of Alkanes and  $\text{NO}_2$ . II. A Radical-Chain Scheme of the Reaction Between Methane and  $\text{NO}_2$ . *Neftekhimiya* 2, 211 (1962).
1659. Topping, Richard M., and Kharasch, Norman. Sulfenic Acids and Their Derivatives. XLI. Sulfenyl Nitrates and Sulfinyl Radicals. *J. Org. Chem.* 27, 4353 (1962).
1660. Townsend, Suzanne Nicholas. Free Radical Scavengers of the Galvinoxyl Type. Univ. Microfilms, Order No. 63-7837.

1661. Tsepalov, V. F., Shlyapintokh, V. Ya., and Chou, P'ei-Huang. Kinetics of Simultaneous Oxidation of Cumene and Ethylbenzene. I. Relation Between the Rate Constants of Elementary Reactions. *Zh. Fiz. Khim.* 38, 52 (1964).

1662. Ueda, Hisashi. Application of Electron Spin Resonance to the Determination of Hydroperoxides. *Anal. Chem.* 35, 2213 (1963).

1663. Ulitskii, V. A. Equilibrium in Dissociation Reactions of Alkanes to Radicals. *Neftekhimiya* 3, 650 (1963).

1664. Vedeneev, V. I. Free Radicals. *Priroda* 49, 10 (1960).

1665. Waring, R. K., Jr., and Sloan, G. J. Association in Biradical Solutions. *J. Chem. Phys.* 40, 772 (1964).

1666. Weber, Harry Walter. Trisubstituted Hydrazyl Free Radicals. Univ. Microfilms, Order No. 63-6396.

1667. Weiss, Joseph J. Electron Transfer in the Formation of Organic Molecular Complexes. *Phil. Mag.* 8, 1169 (1963).

1668. Williamson, Roger Clinton, Jr. Polar Effects in Free Radical Reactions. Univ. Microfilms, Order No. 64-3963.

1669. Windsor, Maurice W. Trapped Radicals at Liquid-Liellium Temperatures by Carbon Resistance Thermometry. Preprints Papers Intern. Symp. Free Radicals, 5th, Uppsala, 73-1-73-15 (1961).

1670. Zakharov, I. V., and Shlyapintokh, V. Ya. Chemiluminescence in Slow Chemical Reactions. III. A Kinetic Study of Hydroperoxide Accumulation in the Catalyzed Oxidation of Ethylbenzene. *Kinetika i Kataliz* 4, 706 (1963).

1671. Zavitsas, Andreas A., and Seltzer, Stanley. The Transition State in Methyl Radical Formation. The Secondary  $\alpha$ -Deuterium Isotope Effect. *J. Am. Chem. Soc.* 86, 3836 (1964).

1672. Zavitsas, Andreas A., and Seltzer, Stanley. Transition State in Methyl Radical Formation. The  $\alpha$ -Deuterium Effect. *Ibid.*, 1265 (1964).

**UNCLASSIFIED**

Security Classification

**DOCUMENT CONTROL DATA - R & D**

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate name) CO, Edgewood Arsenal ATTN: SMUEA-RPRE (1) Edgewood Arsenal, Maryland 21010	2a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>	
3. REPORT TITLE  <b>FREE RADICALS: A BIBLIOGRAPHY, VOLUME I, 1963-1964</b>	2b. GROUP  <b>NA</b>	
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) This is a comprehensive survey of the literature of 1963 to 1964.		
5. AUTHOR(S) (First name, middle initial, last name)  Poziomek, Edward J., and Mosher, William A.		
6. REPORT DATE August 1968	7a. TOTAL NO. OF PAGES 177	7b. NO. OF REFS 1672
8. CONTRACT OR GRANT NO.		9a. ORIGINATOR'S REPORT NUMBER(S)  EASP 100-33
a. PROJECT NO. 1C622401A102	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned (this report))  NA	
c. Task No. 1C622401A10204		
d.		
10. DISTRIBUTION STATEMENT. This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-TSTI-T, Edgewood Arsenal, Maryland 21010.		
11. SUPPLEMENTARY NOTES  Detection and warning investigations	12. SPONSORING MILITARY ACTIVITY  NA	
13. ABSTRACT  (U) This special publication lists 1672 references on free radicals found by the author as a result of a page to page scan of the 1963 to 1964 issues of the Physical and Analytical Chemistry Sections, and the Organic Chemistry Sections of Chemical Abstracts. This publication is divided into 10 sections: Synthesis, Reactions of Free Radicals, Reactions Through Free-Radical Mechanisms, Metal Ions and Free Radicals, Electron Spin Resonance, Spectroscopy, Photolysis, Radiolysis, Electric and Magnetic Phenomena, and General Considerations. The references are arranged alphabetically in each section according to first author. Each reference contains the author, title, and journal citation.		
14. KEYWORDS		
Free radicals Synthesis Mechanism Metal ions Electron spin resonance	Spectroscopy Photolysis Radiolysis Electric and magnetic phenomena Bibliography	

DD FORM 1 NOV 64 1473

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS  
OBSOLETE FOR ARMY USE.**UNCLASSIFIED**

Security Classification